Under boundary Alternatives which contact the mainland coast (1, 1a, 2, and, to a lesser extent, 3), harbor porpoise might be added to the Sanctuary and populations of long-beaked and short-beaked common dolphins and coastal bottlenose dolphins within Sanctuary boundaries would be substantially larger.

DRAFT

Introduction

This section will contain the introduction for the entire marine mammal section including 5a cetaceans and 5b pinnipeds

Range Endpoint Analysis

*The following analysis has been modified from Airamé et al. (2003).

A range endpoint analysis was conducted on cetaceans and pinnipeds to look for biogeographic breaks in their distributions along the coast of North America. Latitudes which represent the end of many species' ranges, either the northern or southern extents, often correspond to major oceanographic features. For example, at Point Conception a known biogeographic boundary, the cool water of the California Current intersects the relatively warm water of the California Countercurrent, which flows north along the coast of southern California. These areas can be highlighted graphically as in Figure 1 where the black rectangle surrounds the bars including species with range termini within the study region. The longer the bars extend in either direction the greater number of species with range termini at the given latitude. Analyzing latitudinal trends in this manner is a common technique applied to examine patterns of distribution, diversity, and structure in marine populations (Horn and Allen, 1978; Roy et al., 1994; Dawson, 2001). This type of information in turn can be used to identify distinct regions or transitional zones in the marine environment and allow managers a better understanding of their resources when making informed spatially explicit management decisions.

There were 49 marine mammal species included in this range endpoint analysis. Information about each species was gathered from field guides and includes the northern and southern range endpoints in 2˚ latitudinal bins. The most significant boundary found in California occurs near Point Conception with a few delphinid species, including the melon-headed whale, pygmy killer whale, false killer whale, short-finned pilot whale, and striped dolphin, found primarily south of there and five species, including the northern right whale dolphin, Dall's porpoise, harbor porpoise, Hubb's beaked whale, and Stejneger's beaked whale found primarily north. This represents over twenty percent of the species examined in this study which is significant given that local oceanographic patterns and habitat features generally do not constrain the distributions of large marine mammals. The majority of marine mammals examined however, were widely distributed along the western coast of North America.

Pinnipeds also exhibited wide distributions from Alaska to central or southern California and Baja California with no biogeographic breaks occurring in the study area. Harbor seals are widespread in coastal habitats of the northern hemisphere. California sea lions are found from Vancouver Island to the southern tip of Baja California. Most of the population of Steller sea lions is in the Gulf of Alaska and the Bering Sea, but small populations are found along the coast as far south as central California. Northern elephant seals are distributed from the Aleutian Islands to Baja California. Although most of the worldwide population of northern fur seals is found on the Pribilof Islands, a small number of northern fur seals are found on Bogoslof Island in the southern Bering Sea, San Miguel Island off southern California, and the Farallon Islands.

Chapter 5a - Cetaceans

Data and Methods

Three types of geo-referenced survey data for cetaceans were used in this report: shipboard surveys from the NMFS Southwest Fisheries Science Center (SWFSC), shipboard and aerial surveys compiled for the Minerals Management Service (MMS) in the Computer Database Analysis System (CDAS), and an aerial survey of bottlenose dolphin. These surveys are summarized in Table 1 and discussed below.

SWFSC Shipboard Surveys

Line-transect surveys of marine mammals were conducted by the SWFSC from late July through early November in 1991, 1993, and 1996, and from late July through early December in 2001. The surveys were conducted off of California in all years and additionally off of Washington and Oregon 1996 and 2001. Survey tracks are shown in figures 2 and 3. Details of the survey methods are described fully by Barlow et al. (2001). Briefly, surveys were conducted aboard the R/V David Starr Jordan and the R/V McArthur. Three observers, two with 25x binoculars and one with the unaided eye, recorded marine mammal sightings including species, group size, and perpendicular distance. Results of these surveys have been used to estimate the abundance of cetaceans along the U.S. West Coast using line-transect methods (Barlow, 2003). Here, SWFSC shipboard survey data are used to calculate density estimates within the current CINMS boundaries (or No Action Alternative (NAA)), the McGinnis study area, and the five proposed boundary Alternatives for the following cetaceans:

Blue Whale (*Balaenoptera musculus*)
Short-beaked Common Dolphin (*Delphinus delphis*)
Long-beaked Common Dolphin (*Delphinus capensis*)
Unidentified Common Dolphin (*Delphinus* sp.)
Humpback Whale (*Megaptera novaeangliae*)
Risso's Dolphin (*Grampus griseus*)

Density and abundance of the above cetaceans were calculated using line-transect methods (Buckland et al., 1993) and the ABUND4 program (Barlow, XXXX). Two major parameters, f(0) and g(0) are required for these calculations. The first parameter, f(0) is a component of the detection function which describes the decrease in sightings as the perpendicular distance from the transect line increases. The value of f(0) is inversely related to the Effective Strip Width (ESW), the width of the viewing area perpendicular to the ship's track over which a species can be reliably sighted, according to the equation: ESW = 1/f(0). The other major line-transect parameter, the detection probability on the transect line or g(0), can not be estimated empirically from the survey data. This parameter is generally determined from information on dive times and surface intervals of marine mammals. Values of g(0) used in this analysis were obtained from Barlow (2003). For abundance estimation, the parameters f(0) and g(0) are used to adjust sightings and effort in order to calculate density, much as the trawl width and catchability coefficient (q) are used to estimate density from a trawl survey.

Values of f(0) were determined empirically by fitting hazard rate detection functions to the sighting distances. Stratification and pooling of the data were used to obtain the simplest and best fitting models. Both group size and geographic strata were tested and the Akaike's Information Criterion (AIC) was used to select between competing models. To examine the value of geographic stratification, detection functions were fit to the entire pooled data sets (all four years) and a geographical subset of the data in Southern California (from 32.3 to 36 degrees North Latitude and east of 122 degrees West Latitude). AIC was compared between the pooled data and the sum of the two strata (southern California and all other west coast locations).

The two common dolphin species and unidentified common dolphins were pooled in order to increase the number of sightings and improve the precision of the f(0) estimate for this category. Estimates of f(0) were lower for the southern California subset than for the entire dataset. Lower f(0) indicates a greater effective strip width and suggests that for some reason (e.g. calmer conditions or behavioral differences) common dolphin were more visible within the study area than for the West Coast as a whole. Because of this difference, and a slight (0.15%) improvement in AIC, geographically specific f(0)'s were used for common dolphin.

Although Barlow (2003) used three group size strata (1-20, 20-60, and >60 individuals) when estimating f(0) coastwide for common dolphin, we have chosen to use two for this study since the f(0) values for the two larger group sizes were similar (0.464 and 0.451 respectively) in the southern California stratum. Although AIC values slightly (0.3% difference) favored 3 group sizes, a valid coefficient of variation (necessary for calculating confidence intervals) for the f(0) values could only be determined when the two larger group size classes were pooled.

Density and abundance were estimated separately for the two common dolphin species and unidentified common dolphins. The unidentified common dolphin densities and abundances were then assigned to the two species according to the proportions of the two species occurring in each Alternative. Density and abundance for the two common dolphin species were then augmented by their individual shares of the unidentified common dolphins. Unidentified common dolphins represented 3-10% of the estimated abundance of long-beak common dolphins and 4-7% of short-beak common dolphins within any boundary Alternative. Because confidence intervals can not be calculated for the augmented data we also present results for calculations based only on fully identified sightings. Because they do not include the unidentified common dolphins, these numbers are obviously underestimates, but they give some idea of the uncertainty in density and abundance estimates.

For blue whale, geographic stratification resulted in a lower f(0) and improved model fit, while group size stratification (1-2 and >2) did not.

Too few Risso's dolphin and humpback whale sightings were available for accurate f(0) estimation in the southern California stratum. Coastwide values of f(0) for these species were taken from Barlow (2003). A summary of input parameters for all species is provided in Table 2.

For the remaining requested cetaceans, too few sightings were recorded within the study area to accurately estimate density. Sightings from the SWFSC shipboard surveys are shown for the above species and:

Bottlenose Dolphin (*Tursiops truncates*)
Gray Whale (*Eschrichtius robustus*)
Killer Whale (*Orcinus orca*)
Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)

SWFSC Aerial Surveys in the Southern California Bight

In addition to the ship surveys, aerial survey sightings from the SWFSC are displayed for gray whale due to the lack of sightings for this species in the ship surveys. Unlike the ship surveys, these aerial surveys are restricted to small areas within the SCB (figure 4) and are conducted year-round approximately every two months. Surveys focused on the area surrounding San Nicolas Island were conducted in 1992-1993 and a second set of surveys focused on San Clemente Island was conducted in 1998-2003. Details of the survey methods are found in Carretta et al. (1995 and 2000). Because of the geographically focused nature of these surveys, the distribution of sightings viewed at a broader scale (i.e. the entire SCB or southern California) largely reflects the distribution of survey effort. Nevertheless, this survey provides useful recent information about the location of gray whale sightings in the SCB. As with all geographically focused surveys, the absence of sightings does not necessarily indicate unsuitable habitat.

Computer Database Analysis System (CDAS)

Seven at-sea surveys from the period 1975 – 1997 compiled in CDAS v2.1 (MMS, 2001) were used to display sightings and effort for the following cetaceans:

Blue Whale (*Balaenoptera musculus*)
Bottlenose Dolphin (*Tursiops truncatus)*
Common Dolphin (*Delphinus delphis*)
Gray Whale (*Eschrichtius robustus*)
Humpback Whale (*Megaptera novaeangliae*)
Killer Whale (*Orcinus orca*)
Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)
Risso's Dolphin (*Grampus griseus*)

Effort is represented by the total length of survey track in each five minute of latitude by five minute of longitude grid cell (figures 5 and 6). Although effort for the bird surveys in the CDAS data set was represented by area swept, this conversion was not used for displaying cetacean survey effort because different effective strip widths apply for different cetaceans and different surveys. The CDAS data, though comprehensive and thorough, were recorded over a period of more than 20 years, during which time distributions of some species are thought to have changed substantially (K. Forney. Pers. comm.). Additionally, some of the older surveys were imprecisely georeferenced making it difficult to locate sightings and reconstruct effort. Consequently, no quantitative analysis was conducted on the CDAS data.

SWFSC Bottlenose dolphin aerial survey

Aerial surveys of bottlenose dolphin were conducted by SWFSC in May 1990, April, June, August, October, and December 1991, February, April, and July 1992, May-August 1993, July 1994, May 1999, and June 2000. The survey covers the mainland coast from Point Montara to the U.S. - Mexico border and the Channel Islands. Coastal bottlenose dolphin are associated with nearshore habitat spending 99% of their time within 500m of shore (Hanson and Defran 1993). Aerial surveys were conducted at an altitude of 213m within 300 to 500m of shore by three observers: inshore, offshore, and belly. Further details of the survey methods are reported by Carretta et al. (1998).

Encounter rates for bottlenose dolphin were calculated for 20km shoreline segments by dividing the total number of on-effort sightings by the total length of survey track falling alongside each segment. Portions of survey track in which the sea state was rougher than Beaufort 4 were eliminated as were those portions for which the glare on the inshore observer window (from which the majority of sightings were made) and the belly window obscured more than 75% of the viewing area. The shoreline segments adjacent to Point Mugu, Camp Pendleton and Los Angeles International airport were treated in the same manner as other segments. Encounter rates in these areas, however, may not accurately reflect bottlenose dolphin abundance because the survey aircraft was frequently required to change course or altitude for safety reasons. Any shoreline segments with less than 5km of effort were eliminated from the analysis. Although all of the Channel Islands were surveyed only two on-effort bottlenose dolphin sightings were recorded in the Channel Islands, both of which occurred off of Santa Catalina Island. Encounter rates were therefore estimated only for the mainland and no OAI analysis was conducted for this species.

Broad scale patterns and Analysis of Boundary Alternatives

Blue Whale (*Balaenoptera musculus*)

Although stock structure of blue whales in the North Pacific is currently disputed with one (Donovan, 1991) to as many as five (Reeves et al., 1998) sub-stocks proposed by different authorities, the most recent stock assessment for this species (Carretta et al., 2002) covers one Eastern North Pacific stock. This stock, which feeds in California waters during the summer and fall and migrates to Mexican waters during the winter (Calambokidis et al., 1990), is believed to be separate from the Gulf of Alaska population (Rice, 1992). The most recent abundance estimate for this stock based on a weighted average of the estimates from the 1991-1996 SWFSC ship surveys (Barlow, 1997) and a 1993 mark-recapture survey (Calambokidis and Steiger, 1994) was 1,940 individuals (Carretta et al., 2002). Blue whales are a federally listed Endangered Species.

Sightings of blue whales from the SWFSC ship surveys and the CDAS surveys (figure 7) occur throughout southern California in shelf, slope, and offshore waters. A notable cluster of sightings is found to the west of San Miguel Island in shelf waters. Because of the uneven distribution of survey effort, the sightings should be used only as confirmation that blue whales do exist in a given area; the absence of sightings for this widely ranging species may reflect insufficient survey effort rather than unsuitable habitat.

Estimates of the summer and fall abundance of blue whales within the NAA, the five boundary Alternatives, and the McGinnis study area were derived from the 1991-2002 SWFSC ship surveys described above and are summarized in Table 3. Because of the relatively small number of on-effort sightings (4-14) and the uncertainty in the line transect input parameters, confidence intervals for the abundance estimates are wide and overlap substantially among different Alternatives. Nevertheless, large differences in estimated blue whale density and abundance exist among the Alternatives. The NAA does seem to be well placed to capture regions of high blue whale density within the SCB as it exhibits higher estimated density than any of the Alternatives or the McGinnis study area. Sharp increases in estimated blue whale abundance relative to that of the NAA are apparent in Alternatives 1, 1a, and 2. The OAI shows that, although none of the Alternatives provide higher density than the NAA, Alternatives 1 and 1a provide the greatest relative increase in blue whale abundance for the smallest relative increase in area.

Bottlenose Dolphin (*Tursiops truncatus*)

Two populations of bottlenose dolphin are found in California waters: an offshore population found at distances greater than 1km from shore in the SCB and extending to the offshore limits (300 nmi) of the SWFSC ship surveys throughout much of California waters, and a coastal population that is found within 500m of shore from San Francisco (although most sightings are south of Point Conception) south into Baja California, Mexico (Carretta et al., 2002). The abundance of the offshore population in U.S. west coast waters estimated from the 1991-1996 SWFSC ship surveys is 956 individuals (Barlow, 1997). The most recent estimate for the coastal population based on 1999-2000 tandem aerial surveys by the SWFSC (a subset of the data used to map encounter rates in this report) is 206 individuals (Carretta et al., 2002). Although the abundance of the coastal population in California overall appears to be stable (Dudzick, 1999), there is movement along the coast; some of which appears to be related to seasonal and interannual changes in water temperature (Hansen and Defran, 1990; Wells et al., 1990). Bottlenose dolphins are not a federally listed species.

Sightings of bottlenose dolphin from the SWFSC ship surveys and the CDAS surveys (figure 8) occur mostly in shelf and nearshore waters of the SCB. Both populations, coastal and offshore, are apparent in the sightings. A string of sightings likely to be from the coastal population occurs along the coast from west of Santa Barbara to Ventura and another between Dana Point and San Diego. Sightings that can be attributed to the offshore population occur throughout the SCB with a cluster of sightings from the SWFSC surveys found in the Santa Cruz basin. Because of the uneven distribution of survey effort, the sightings should be used only as confirmation that bottlenose dolphin do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than unsuitable habitat.

Encounter rates of coastal bottlenose dolphin derived from the 1990-2000 SWFSC aerial surveys (figure 9) vary along the central and southern California coast with the highest encounter rates observed to the south of Santa Barbara. Notable hotspots (encounter rates in the highest quintile or 0.311-0.864 individuals/km) for this species occur between Carpinteria and Ventura, Point Dume and Santa Monica, San Pedro Bay and Newport Beach, and near Oceanside and La Jolla. Many of these areas of high encounter rates contain long sandy beaches and/or river mouths that constitute the preferred habitat of coastal bottlenose dolphins.

Estimates of the mean encounter rates and abundance of the coastal stock of bottlenose dolphin within Alternatives 1-3 and the McGinnis study area were derived from the 1990 - 2000 SWFSC aerial coastal bottlenose dolphin surveys described above and are summarized in Table 4. No analysis was possible for the other Alternatives and the NAA since encounter rates were only determined for the mainland coast. Mean encounter rates and estimated abundance were greatest in Alternatives 1 and 1a and the study area. Substantial increases in both the mean encounter rate and the estimated abundance were observed for each increase in shoreline length. Coastal bottlenose dolphins are known to occur within the CINMS, but were not sighted during the aerial surveys.

Long-beaked (*Delphinus capensis*) and Short-beaked (*Delphinus delphis*) Common Dolphin

Common dolphin have recently been recognized as two distinct species, the long-beaked (*Delphinus capensis*) and the short-beaked (*Delphinus delphis*), based on genetic and morphological differences (Heyning and Perrin, 1994; Rosel et al., 1994). Within California coastal waters, the distribution of the two species overlaps with long-beaked common dolphins found in near-shore (<50 nmi of the coast) waters from Baja California, Mexico to central California. Short-beaked common dolphin have a broader distribution along the west coast of North America extending from approximately the California/Oregon border south into Mexico to approximately 13° N (Carretta et al., 2002). Short-beaks are also found farther from the coast with many sightings in the SWFSC ship surveys occurring near the offshore limit (300 nmi) of the survey. Although common dolphins are frequently spotted in aerial surveys, the two species can not be reliably distinguished from the air (Forney et al., 1995). The most recent abundance estimate for the California stock of long-beaked common dolphin based on data from the 1991-1996 SWFSC ship surveys (Barlow, 1997) is 32,239 individuals (Carretta et al., 2002). Estimated short-beaked common dolphin abundance throughout its US west coast range based on the same data is 373,573 individuals, making it the most abundant cetacean in California waters. The distributions of both species appear to vary seasonally and interannually with highest densities of long-beaks in California waters occurring during warm-water events (Heyning and Perrin, 1994).

Sightings of common dolphins are divided into those that were not identified to species from the SWFSC ship surveys and the CDAS surveys (figure 10) and those from the SWFSC ship surveys that could be identified as either long-beaked (figure 11) or short-beaked (figure 12). Common dolphins not identified to species were frequently sighted in the SCB in the CDAS surveys and were twice sighted in Monterey Bay. The SWFSC surveys include several sightings in shelf waters between Point Conception and Point Piedras Blancas as well as many throughout the SCB. Sightings of long-beaked common dolphins occurred predominantly in inshore shelf waters from Point Piedras Blancas south to Newport Beach. There were several sightings in the Santa Barbara Channel and near Anacapa Island. Sightings of short-beaked common dolphins were much more numerous and occurred throughout Central and Southern California shelf and offshore waters, although offshore sightings predominate north of Monterey Bay. Because of the uneven distribution of survey effort, the sightings should be used only as confirmation that common dolphins do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than unsuitable habitat.

Estimates of the summer and fall abundance of long-beaked and short-beaked common dolphin within the NAA, the five boundary Alternatives, and the McGinnis study area were derived from the 1991-2002 SWFSC ship surveys described above and are summarized in Tables 5 (long-beaks) and 6 (short-beaks). These results represent the combined estimates of species specific abundance, and because many common dolphin could not be identified to species, an area specific proportion of the estimated unidentified common dolphin abundance. The unadjusted abundance estimates for long-beaks (Table 7) and short-beaks (Table 8) are presented as well along with their associated confidence intervals in order to give some idea of the uncertainty in the abundance estimates. Although the adjusted estimates are believed to more accurate estimates of the density and abundance, the adjustments preclude calculation of confidence intervals. Because of the relatively small number of on-effort sightings (3-7 for long-beaks, and 4-19 for short-beaks) and the uncertainty in the line transect input parameters, confidence intervals for the abundance estimates are wide and overlap substantially among different Alternatives.

Estimated long-beaked common dolphin density is highest in Alternative 2 and estimated abundance is highest in Alternatives 1, 1a, and the McGinnis study area. Notable increases in estimated blue whale abundance relative to that of the NAA are apparent with each increase in Alternative size with the exception of Alternative 5 which shows only a 7% increase. The OAI shows that, of the proposed boundary Alternatives, Alternative 3 provides the greatest relative increase in both density and abundance relative for the smallest relative increase in area. Overall, the OAI is highest for the McGinnis study area.

Estimated short-beaked common dolphin density is highest in Alternative 4 and estimated abundance is highest in Alternatives 1, 1a, and the McGinnis study area. Estimated abundance for this species seems to fall into three relatively distinct groups: the NAA and Alternative 5 with approximately 2,500 individuals, Alternatives 2-4 with around 10,000 individuals, and Alternatives 1 and 1a and the McGinnis study area with around 20,000 individuals. The OAI shows that Alternative 4 provides the greatest relative increase in both density and abundance relative to the NAA for the smallest relative increase in area.

Gray Whale

Gray whales are currently found only in the North Pacific with two separate stocks recognized (Angliss and Lodge, 2002). The Western North Pacific stock is distributed throughout eastern Asia (Rice, 1981; Rice et al., 1984) and the Eastern North Pacific stock occurs from its summer feeding habitat in the northern Bering and Chukchi Seas (Rice and Wolman, 1971; Berzin, 1984; Nerini, 1984) to its winter calving habitat along the west coast of Baja California, Mexico (Rice et al,. 1984). The fall (southbound) migration takes place beginning in November – December (Rugh et al., 2001) and the spring (northbound) migration occurs from mid-February through May (Rice et al., 1981, 1984; Poole, 1984). The most recent estimate of the size of the Eastern North Pacific gray whale stock based on systematic counts of migrating (southbound) whales by shore-based observers at Granite Canyon, CA in 1997-98 is 26,635 individuals (Angliss and Lodge, 2002). There is evidence of a positive trend in gray whale abundance since 1992-1993.

Sightings of gray whales from the SWFSC aerial surveys and the CDAS surveys (figure 13) reflect the broad nearshore distribution of this species during its migrations through California waters. Gray whale sightings occur in nearshore waters throughout the SCB, including the SBC, and near the Channel Islands. The cluster of sightings around San Clemente Island is probably more reflective of survey effort than a particular preference for this location. Because of the uneven distribution of survey effort, the sightings should be used only as confirmation that gray whales do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than unsuitable habitat.

Humpback Whale

Evidence from survey data and genetic analyses supports the division of humpback whales into three populations within U.S. Pacific waters (Carretta et al., 2002), one of which migrates from coastal Central America and Mexico to the west coast of the U.S. and into British Columbia during the summer and fall (Steiger et al., 1991; Calambokidis et al., 1993). This population, referred to as the Eastern North Pacific stock, passes through the study area during its summer and fall migration. The most recent abundance estimate for this stock based on a 1998-2000 mark-recapture survey (Calambokidis et al., 2001) was 1,940 individuals and a modest upward trend in abundance since 1990 is apparent (Carretta et al., 2002). Humpback whales are a federally listed Endangered Species.

Sightings of humpback whales from the SWFSC ship surveys and the CDAS surveys (figure 14) occur most frequently in shelf waters to the north of Point Conception. Scattered sightings also occur in the SCB (including several in the SBC) and in offshore waters. Because of the uneven distribution of survey effort, the sightings should be used only as confirmation that humpback whales do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than unsuitable habitat.

Estimates of the summer and fall abundance of humpback whales within the NAA, the five boundary Alternatives, and the McGinnis study area were derived from the 1991-2002 SWFSC ship surveys described above and are summarized in Table 9. Because some of the sightings recorded as “Unidentified Large Whale” (including one that fell in Alternatives 1 and 1a) were likely to be humpback whales (Carretta et al., 2002), abundance estimates in Alternatives 1 and 1a may be negatively biased. Very small numbers of on-effort sightings (0-4) make the density and abundance estimates for this species extremely uncertain. No on-effort sightings were recorded within the NAA and only 1 on-effort sighting was recorded in Alternatives 3-5 resulting in abundance estimates of approximately 10 individuals for these three Alternatives. Four on-effort sightings occurred in Alternatives 1, 1a, 2, and the McGinnis study area resulting in abundance estimates of approximately 50 individuals for these four areas. Because no on-effort sightings were recorded in the NAA, it was not possible to calculate the OAI for humpback whales.

Killer Whale (*Orcinus orca*)

Relatively little is known about the killer whales found in California waters compared to the well studied populations of Alaska and the Pacific Northwest. Nevertheless, four separate types of killer whales have been identified and regularly sighted in California. These groups differ in their behavior, genetics, distribution, coloration and preferred prey (Ford and Fisher, 1982; Baird and Stacey, 1988; Baird et al., 1992; Hoelzel et al. 1998). Three of the four types found in California waters (the resident, transient, and offshore types) were first identified and characterized in the eastern North Pacific. The fourth (the “LA pod”) has not been recorded outside of southern California and Baja California, Mexico.

Resident type killer whales have primarily been sighted from the Aleutian Islands south to Puget Sound, although there have been sightings of members of two resident type pods as far south as Monterey Bay in January (Carretta et al., 2002). No sightings of this type have been recorded in the study area. The most recent estimate of the size of the resident type killer whale population in southern British Columbia, Canada through central California based on direct counts of identified individuals is 82 animals (Carretta et al., 2002).

Transient type whales are unpredictable in their seasonal movements and travel throughout an extensive range with some individuals recorded in both central California and Southeast Alaska (Goley and Straley, 1994). Transients are the most frequently spotted type of killer whale off of central California (Black et al., 1997). They specialize on hunting marine mammals including seals and sea lions as well as large whales (such as gray whales) and their calves during seasonal whale migrations. No estimate of the size of the transient type population is available.

Offshore type killer whales, first identified as a separate group off western Vancouver Island, Canada in the 1980's, are less well studied than transients (Black et al., 1997). The first offshore type individuals in California were identified from photos taken in 1993 off of Point Conception, however, they may have been present in this area since the mid-1980's. More recently, this type has been documented off Los Angeles and in Monterey Bay (Black et al., 1997). The offshore type travels in larger groups and is more vocal than transient types and has not been observed feeding on marine mammals. The most recent estimate of the size of the offshore type killer whale population in Washington, Oregon, and California based on the 1991-1996 SWFSC ship surveys is 285 animals (Carretta et al., 2002). This is considered a conservative estimate.

The "LA Pod," named for the location where they are most frequently observed, may not be not be a distinct type, but has yet to be linked to one of the other two. Members of this group were first photographed in 1982 and have been spotted from from Monterey south to the Sea of Cortez, Mexico. They have never been observed feeding on marine mammals (Black et al., 1997).

Few sightings of killer whales were recorded in the SWFSC ship surveys and the CDAS surveys (figure 15). Scattered sightings occur along the shelf and slope (with a few offshore sightings) north of Point Conception. Only two sightings exist in the SCB, one near Santa Barbara and one off of San Diego. Because of the uneven distribution of survey effort, the sightings should be used only as confirmation that killer whales do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than unsuitable habitat.

Because so little distributional information or survey sightings exist for killer whales in the study area, it is difficult to evaluate the potential impacts of different boundary alternatives. Alternatives that have the potential to protect killer whales' prey species, including marine mammals such as gray whales and pinnipeds as well as a variety of fish and cephalopod species, may provide indirect benefits to killer whales as well.

Pacific White-sided Dolphin

Pacific white-sided dolphins are found throughout the temperate waters of the North Pacific, with most sightings in California waters occurring in shelf and slope. Two forms of this species occur off of California: a northern form ranging from the SCB north to Alaska, and a southern form found from Baja California, Mexico north to approximately 36° N (Carretta et al., 2002). Although both forms are found in the SCB genetic (Lux et al., 1997) and morphological (Walker et al., 1986; Chivers et al., 1993) differences indicate little mixing. Seasonal movements along the U.S. West Coast have been documented with most animals found in California waters during the colder winter months (Green et al., 1992; Forney, 1994). Because the SWFSC ship surveys are conducted in the summer and fall, little information is available about their distribution in southern California. Because the two forms are indistinguishable in the field, they are treated as one stock for management purposes. The most recent stock assessment (Carretta et al., 2002) estimates a population size of 25,825 individuals along the U.S. West coast based on the 1991-1996 SWFSC ship surveys.

Pacific white-sided dolphins were frequently sighted in the CDAS surveys and occasionally recorded in the SWFSC ship surveys (figure 16). Many sightings occur along the shelf and slope (with a few offshore sightings) throughout central and southern California. Sightings are also scattered throughout the SCB. Relatively few sightings of this species were recorded in the SWFSC ship surveys because of the previously mentioned seasonal changes in abundance. Because of the uneven distribution of survey effort, the sightings should be used only as confirmation that Pacific white-sided dolphins do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than unsuitable habitat. The offshore distribution of this species is particularly under-represented in the sightings map because effort in the CDAS surveys was much greater in nearshore and shelf waters.

Risso's Dolphin

Within U.S. Pacific waters, Risso's dolphin are divided into two stocks, a Hawaiian stock, and a California/Oregon/Washington stock. Green et al. (1992) suggest that Risso's dolphin in California move northward into Oregon and Washington in late spring and summer. The southern end of this stock's range appears to occur somewhere along the coast of Baja California, Mexico. Although Risso's dolphin are generally found in slope and offshore waters in Washington, Oregon, and northern California, in southern California they are also found in large numbers in shelf waters of the SCB (Carretta et al., 2002). The most recent abundance estimate for the California/Oregon/Washington stock based on data from the 1991-1996 SWFSC ship surveys (Barlow, 1997) is 16,483 individuals (Carretta et al., 2002). The distribution of Risso's dolphin is highly variable, however, and seasonal and interannual shifts are common (Forney and Barlow, 1998).

Risso's dolphins were frequently sighted in the SWFSC ship surveys and the CDAS surveys (figure 17). Many sightings occur along the shelf and slope (with a few offshore sightings) throughout central and southern California. Sightings are also scattered throughout the SCB with clusters of sightings at both the western and eastern ends of the SBC, but relatively few in the channel itself. Because of the uneven distribution of survey effort, the sightings should be used only as confirmation that Risso's dolphins do exist in a given area; the absence of sightings may reflect insufficient survey effort rather than unsuitable habitat.

Estimates of the summer and fall abundance of Risso's dolphin within the NAA, the five boundary Alternatives, and the McGinnis study area were derived from the 1991-2002 SWFSC ship surveys described above and are summarized in Table 10. Because of the relatively small number of on-effort sightings (4-21) and the uncertainty in the line transect input parameters, confidence intervals for the abundance estimates are wide and overlap substantially among different Alternatives. Estimated Risso's dolphin density is highest in Alternative 3 and estimated abundance is highest in Alternative 1 and the McGinnis study area. Notable increases in estimated abundance relative to that of the NAA are apparent with each increase in Alternative size with the exception of Alternative 5 which shows only a 7% increase. The OAI shows that, of the proposed boundary Alternatives, Alternative 3 provides the greatest relative increase in both density and abundance relative for the smallest relative increase in area. Overall, the OAI is highest for the McGinnis study area.

Other Cetaceans

In addition to the requested species, several other species of cetaceans are known to occur within the study area. While no quantitative analysis was conducted for these species it is important to recognize that they may be impacted by changes to the boundaries of the CINMS and further investigation into these species may be warranted.

Along the west coast of the U.S., harbor porpoise (Phocoena phocoena) are found in coastal waters from Alaska south to Point Conception. Harbor porpoise on the west coast tend to form geographically and genetically distinct sub-populations with little mixing or movement among them. A Morro Bay stock of harbor porpoise is one of four stocks identified in California waters by the most recent stock assessment report (Carretta et al., 2002). The Morro Bay stock extends from just south of Monterey to Point Conception, although the northern boundary which divides the Morro Bay stock from the Monterey Bay stock is somewhat arbitrary. The most recent estimate of the size of the Morro Bay stock based on a 1997-1999 aerial survey is 932 individuals (Carretta et al., 2002). Alternatives 1, 1a, and 2 (and a small portion of Alternative 3) as well as the McGinnis study area extend north of Point Conception and incorporate an unknown number of harbor porpoises.

Summary

- Of those species for which abundance could be estimated (blue whale, bottlenose dolphin, long-beaked and short-beaked common dolphin, humpback whale, and Risso's dolphin) Alternatives 1 and 1a provide the greatest estimated abundance within their boundaries, though density is often higher in the smaller alternatives

- Although their populations could not be estimated quantitatively, killer whales and gray whales are know to use the waters around and within the CINMS as feeding and migratory habitat respectively.

- Under boundary Alternatives which contact the mainland coast (1, 1a, 2, and, to a lesser extent, 3), harbor porpoise might be added to the Sanctuary and populations of long-beaked and short-beaked common dolphins and coastal bottlenose dolphins within Sanctuary boundaries would be substantially larger.

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Table and Figure Legends:

Table 1. Summary of marine mammal field surveys used in this chapter.

Table 2. Line transect parameters used to estimate the abundance of selected cetaceans within the six proposed boundary Alternatives, the current CINMS boundaries, and the McGinnis (2000) study area. Numbers in bold are from Barlow (2003).

Table 3. Blue whale. Sightings, estimated density and abundance, coefficient of variation (CV) and upper and lower 95% confidence limits for the abundance estimate, and the Optimal Area Index (OAI) for the six proposed boundary Alternatives, the No Action Alternative (NAA), and the McGinnis (2000) study area (SA). Analysis based on data from SWFSC ship surveys 1991-2001.

Table 4. Coastal bottlenose dolphin. Sightings, mean encounter rate, and estimated abundance for four proposed boundary Alternatives and the McGinnis (2000) study area. No analysis was done for the NAA or Alternatives 4-5 since encounter rates were calculated only for the mainland coast. Analysis based on data from the SWFSC aerial coastal bottlenose dolphin surveys 1990-2000.

Table 5. Long-beaked common dolphin. Confirmed sightings (identified to species), estimated density and abundance (corrected for unidentified common dolphin sightings), and the Optimal Area Index (OAI) for the six proposed boundary Alternatives, the No Action Alternative (NAA), and the McGinnis (2000) study area (SA). Analysis based on data from SWFSC ship surveys 1991-2001.

Table 6. Short-beaked common dolphin. Confirmed sightings (identified to species), estimated density and abundance (corrected for unidentified common dolphin sightings), and the Optimal Area Index (OAI) for the six proposed boundary Alternatives, the No Action Alternative (NAA), and the McGinnis (2000) study area (SA). Analysis based on data from SWFSC ship surveys 1991-2001.

Table 7. Long-beaked common dolphin. Sightings, estimated density and abundance, coefficient of variation (CV) and upper and lower 95% confidence limits for the abundance estimate (not corrected for unidentified common dolphin sightings), and the Optimal Area Index (OAI) for the six proposed boundary Alternatives, the No Action Alternative (NAA), and the McGinnis (2000) study area (SA). Analysis based on data from SWFSC ship surveys 1991-2001.

Table 8. Short-beaked common dolphin. Sightings, estimated density and abundance, coefficient of variation (CV) and upper and lower 95% confidence limits for the abundance estimate (not corrected for unidentified common dolphin sightings), and the Optimal Area Index (OAI) for the six proposed boundary Alternatives, the No Action

Alternative (NAA), and the McGinnis (2000) study area (SA). Analysis based on data from SWFSC ship surveys 1991-2001.

Table 9. Humpback whale. Sightings, estimated density and abundance, coefficient of variation (CV) and upper and lower 95% confidence limits for the abundance estimate for the six proposed boundary Alternatives, the No Action Alternative (NAA), and the McGinnis (2000) study area (SA). Calculation of the Optimal Area Index (OAI) was not possible due to a lack of sightings within the NAA. Analysis based on data from SWFSC ship surveys 1991-2001.

Table 10. Risso's dolphin. Sightings, estimated density and abundance, coefficient of variation (CV) and upper and lower 95% confidence limits for the abundance estimate, and the Optimal Area Index (OAI) for the six proposed boundary Alternatives, the No Action Alternative (NAA), and the McGinnis (2000) study area (SA). Analysis based on data from SWFSC ship surveys 1991-2001.

Figure 1. Biogeographic Breaks in the Distribution of Marine Mammals from Baja California to Alaska (modified from Airamé et al. 2003).

Figure 2. Survey tracks for the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001. Entire extent of the surveys.

Figure 3. Survey tracks for the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 in central and southern California waters.

Figure 4. Survey tracks for the Southwest Fisheries Science Center (SWFSC) aerial surveys conducted in the vicinity of San Nicolas (1992-1993) and San Clemente (1998-2003) islands. Reprinted with permission from J. Carretta, SWFSC.

Figure 5. Survey effort (kilometers of survey track) for the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1. Entire extent of the surveys.

Figure 6. Survey effort (kilometers of survey track) for the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1 in central and southern California waters.

Figure 7. Blue whale. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1.

Figure 8. Bottlenose dolphin. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven

surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1.

Figure 9. Bottlenose dolphin (coastal population). Encounter rates (#/km) based on data from the Southwest Fisheries Science Center (SWFSC) aerial surveys 1990-2000. Although coastal bottlenose dolphin are known to exist around the Channel Islands, too few sightings were available for accurate estimation of encounter rates.

Figure 10. Common dolphin (unidentified). Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1.

Figure 11. Long-beaked common dolphin. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001.

Figure 12. Short-beaked common dolphin. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001.

Figure 13. Gray whale. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) aerial surveys conducted near San Nicolas (1992-1993) and San Clemente (1998-2003) islands and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1.

Figure 14. Humpback whale. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1.

Figure 15. Killer whale. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1.

Figure 16. Pacific white-sided dolphin. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1.

Figure 17. Risso’s dolphin. Sightings and group size (where available) from the Southwest Fisheries Science Center (SWFSC) ship surveys 1991-2001 and the seven surveys of marine mammals compiled in the Computer Database Analysis System (CDAS) v2.1.

Survey	Dates	Platform	Months	Marine Mammal Sightings	Marine Mammal Individuals
Southwest Fisheries Science Center Ship Surveys	1991, 1993, 1996, 2001	ship	July - December	2963	87402
Southwest Fisheries Science Center Aerial SCB Surveys	1992-1993 1998-2003	airplane	Year-round	37 (Gray whale)	-
Southwest Fisheries Science Center Coastal Bottlenose Dolphin Surveys	1990-2000	airplane	February - December (most effort in summer)	311 (Bottlenose Dolphin)	3190
Minerals Management Service Aerial Surveys - CDAS	1980-1983	airplane (high altitude)	Year-round	2217	77988
Minerals Management Service Aerial Surveys - CDAS	1980-1983	airplane (low altitude)	Year-round	4089	40528
California Department of Fish and Game, Office of Spill Prevention and Response - CDAS	1994-1997	airplane (low altitude)	Year-round	351	1027
Southern California Bight High Aerial Survey - CDAS	1975-1978	airplane (high altitude)	Year-round	695	68557
Southern California Bight Low Aerial Survey - CDAS	1975-1978	airplane (low altitude)	Year-round	1319	15067
Southern California Bight Ship Survey - CDAS	1975-1978	ship	Year-round	3209	112136
Southern California Bight, Minerals Management Service Survey - CDAS	1995-1997	airplane (low altitude)	Year-round	898	3437

Table 1.

Alternative	Area (km^2)	Sightings	Density	Estimated Abundance	CV	Lower 95% Confidence Interval	Upper 95% Confidence Interval	Δ Area (%)	Δ Density (%)	Δ Abundance (%)	Density OAI (relative)	Abundance OAI (absolute)
NAA	*3,745*	4	0.00807	30	0.93	6	141	-	-	-	-	-
5	4,536	**4**	0.00712	**32**	0.78	8	124	21.1	-11.77	6.67	-0.557	0.316
4	7,981	**4**	0.004	**32**	0.73	9	115	113.1	-50.43	6.67	-0.446	0.059
3	9,044	**4**	0.00358	**32**	0.72	9	114	141.5	-55.64	6.67	-0.393	0.047
2	13,736	**7**	0.006	**82**	1.34	11	598	266.8	-25.65	173.33	-0.096	0.650
1a	22,591	**14**	0.00587	**133**	0.4	63	283	503.2	-27.26	343.33	**-0.054**	0.680
1	22,613	**14**	0.00587	**133**	0.4	63	283	503.8	-27.26	343.33	**-0.054**	**0.681**
SA	*17,093*	*8*	*0.0053*	*91*	*0.44*	*40*	*208*	*356.4*	*-33.95*	*203.33*	*-0.095*	*0.570*

Table 3.

Alternative	Area (km^2)	Mainland Shoreline (km)	Individuals Sighted	Mean Encounter Rate (#/km)	Estimated Abundance
NAA	*3,745*	0	-	-	-
5	4,536	0	-	-	-
4	7,981	0	-	-	-
3	9,044	20.32	5	0.04	1
2	13,736	140.02	199	0.11	15
1a	22,591	277.64	1112	*0.23*	63
1	22,613	277.64	1112	*0.23*	63
SA	*17,093*	*277.64*	*1112*	*0.23*	*63*

Table 4.

Alternative	Area (km^2)	Confirmed Sightings	Corrected Density	Corrected Abundance	Δ Area (%)	Δ Density (%)	Δ Abundance (%)	Density OAI (relative)	Abundance OAI (absolute)
NAA	*3,745*	3	1.41	5,262	-	-	-	-	-
5	4,536	**3**	1.24	**5,620**	21.1	-11.83	6.80	-0.560	0.322
4	7,981	**4**	0.75	**5,967**	113.1	-46.79	13.40	-0.414	0.118
3	9,044	**4**	0.67	**6,061**	141.5	-52.31	15.18	-0.370	0.107
2	13,736	**6**	**1.72**	**23,649**	266.8	22.52	349.42	**0.084**	**1.310**
1a	22,591	**7**	1.16	**26,115**	503.2	-17.73	396.29	-0.035	0.787
1	22,613	**7**	1.16	**26,141**	503.8	-17.73	396.78	-0.035	0.788
SA	*17,093*	*7*	*1.59*	*27,138*	*356.4*	*12.98*	*415.73*	*0.036*	*1.166*

Table 5.

Alternative	Area (km^2)	Confirmed Sightings	Corrected Density	Corrected Abundance	Δ Area (%)	Δ Density (%)	Δ Abundance (%)	Density OAI (relative)	Abundance OAI (absolute)
NAA	*3,745*	4	0.62	2,330	-	-	-	-	-
5	4,536	**4**	0.55	**2,489**	21.1	-11.83	6.82	-0.560	0.323
4	7,981	**8**	**1.17**	**9,356**	113.1	88.39	301.55	**0.781**	**2.666**
3	9,044	**8**	**1.05**	**9,503**	141.5	68.86	307.86	0.487	2.176
2	13,736	**9**	**0.78**	**10,756**	266.8	25.85	361.65	0.097	1.356
1a	22,591	**19**	**0.92**	**20,713**	503.2	47.35	788.97	0.094	1.568
1	22,613	**19**	**0.92**	**20,733**	503.8	47.35	789.85	0.094	1.568
SA	*17,093*	*16*	*1.13*	*19,321*	*356.4*	*81.66*	*729.25*	*0.229*	*2.046*

Table 6.

Alternative	Area (km^2)	Sightings	Density	Estimated Abundance	CV	Lower 95% Confidence Interval	Upper 95% Confidence Interval	Δ Area (%)	Δ Density (%)	Δ Abundance (%)	Density OAI (relative)	Abundance OAI (absolute)
NAA	*3,745*	3	1.4052	5,262	-	-	-	-	-	-	-	-
5	4,536	**3**	1.23894	**5,620**	-	-	-	21.1	-11.83	6.80	-0.560	0.322
4	7,981	**4**	0.71895	**5,738**	1.06	1,047	31,439	113.1	-48.84	9.05	-0.432	0.080
3	9,044	**4**	0.64439	**5,828**	1.01	1,127	30,151	141.5	-54.14	10.76	-0.383	0.076
2	13,736	**6**	**1.68799**	**23,186**	0.74	6,349	84,672	266.8	20.12	340.63	**0.075**	**1.277**
1a	22,591	**7**	1.135	**25,641**	0.69	7,547	87,118	503.2	-19.23	387.28	-0.038	0.770
1	22,613	**7**	1.135	**25,666**	0.69	7,554	87,204	503.8	-19.23	387.76	-0.038	0.770
SA	*17,093*	*7*	*1.5638*	*26,731*	*0.66*	*8,226*	*86,869*	*356.4*	*11.29*	*408.00*	*0.032*	*1.145*

Table 7.

Alternative	Area (km^2)	Sightings	Density	Estimated Abundance	CV	Lower 95% Confidence Interval	Upper 95% Confidence Interval	Δ Area (%)	Δ Density (%)	Δ Abundance (%)	Density OAI (relative)	Abundance OAI (absolute)
NAA	*3,745*	4	0.62225	2,330	-	-	-	-	-	-	-	-
5	4,536	**4**	0.54862	**2,489**	-	-	-	21.1	-11.83	6.82	-0.560	0.323
4	7,981	**8**	**1.12728**	**8,997**	1	1,760	46,003	113.1	81.16	286.14	**0.718**	**2.530**
3	9,044	**8**	**1.01036**	**9,138**	1	1,787	46,724	141.5	62.37	292.19	0.441	2.065
2	13,736	**9**	**0.76778**	**10,546**	0.95	2,190	50,786	266.8	23.39	352.62	0.088	1.322
1a	22,591	**19**	**0.90022**	**20,337**	0.57	7,191	57,515	503.2	44.67	772.83	0.089	1.536
1	22,613	**19**	**0.90022**	**20,357**	0.57	7,198	57,572	503.8	44.67	773.69	0.089	1.536
SA	*17,093*	*16*	*1.1134*	*19,032*	*0.6*	*6,419*	*56,428*	*356.4*	*78.94*	*716.82*	*0.221*	*2.011*

Table 8.

Alternative	Area (km^2)	Sightings	Density	Estimated Abundance	CV	Lower 95% Confidence Interval	Upper 95% Confidence Interval
NAA	*3,745*	0	0	0	-	-	-
5	4,536	**1**	**0.00234**	**11**	1	2	56
4	7,981	**1**	**0.00131**	**10**	1	2	51
3	9,044	**1**	**0.00118**	**11**	1	2	56
2	13,736	**4**	**0.00375**	**52**	2.33	4	754
1a	22,591	**4**	**0.0023**	**51**	0.91	11	234
1	22,613	**4**	**0.00226**	**51**	0.91	11	234
SA	*17,093*	*4*	*0.0031*	*53*	*0.82*	*13*	*216*

Table 9.

Alternative	Area (km^2)	Sightings	Density	Estimated Abundance	CV	Lower 95% Confidence Interval	Upper 95% Confidence Interval	Δ Area (%)	Δ Density (%)	Δ Abundance (%)	Density OAI (relative)	Abundance OAI (absolute)
NAA	*3,745*	4	0.12831	481	0.54	178	1,296	-	-	-	-	-
5	4,536	**4**	0.11313	**513**	0.54	190	1,383	21.1	-11.83	6.65	-0.560	0.315
4	7,981	**10**	0.12535	**1000**	0.46	424	2,360	113.1	-2.31	107.90	-0.020	0.954
3	9,044	**12**	**0.16215**	**1466**	0.46	621	3,460	141.5	26.37	204.78	**0.186**	**1.447**
2	13,736	**13**	**0.13464**	**1849**	0.44	811	4,217	266.8	4.93	284.41	0.018	1.066
1a	22,591	**21**	**0.12975**	**2931**	0.45	1,263	6,801	503.2	1.12	509.39	0.002	1.012
1	22,613	**21**	**0.12975**	**2934**	0.45	1,265	6,808	503.8	1.12	509.98	0.002	1.012
SA	*17,093*	*21*	*0.1788*	*3056*	*0.42*	*1,387*	*6,734*	*356.4*	*39.33*	*535.34*	*0.110*	*1.502*

Table 10.

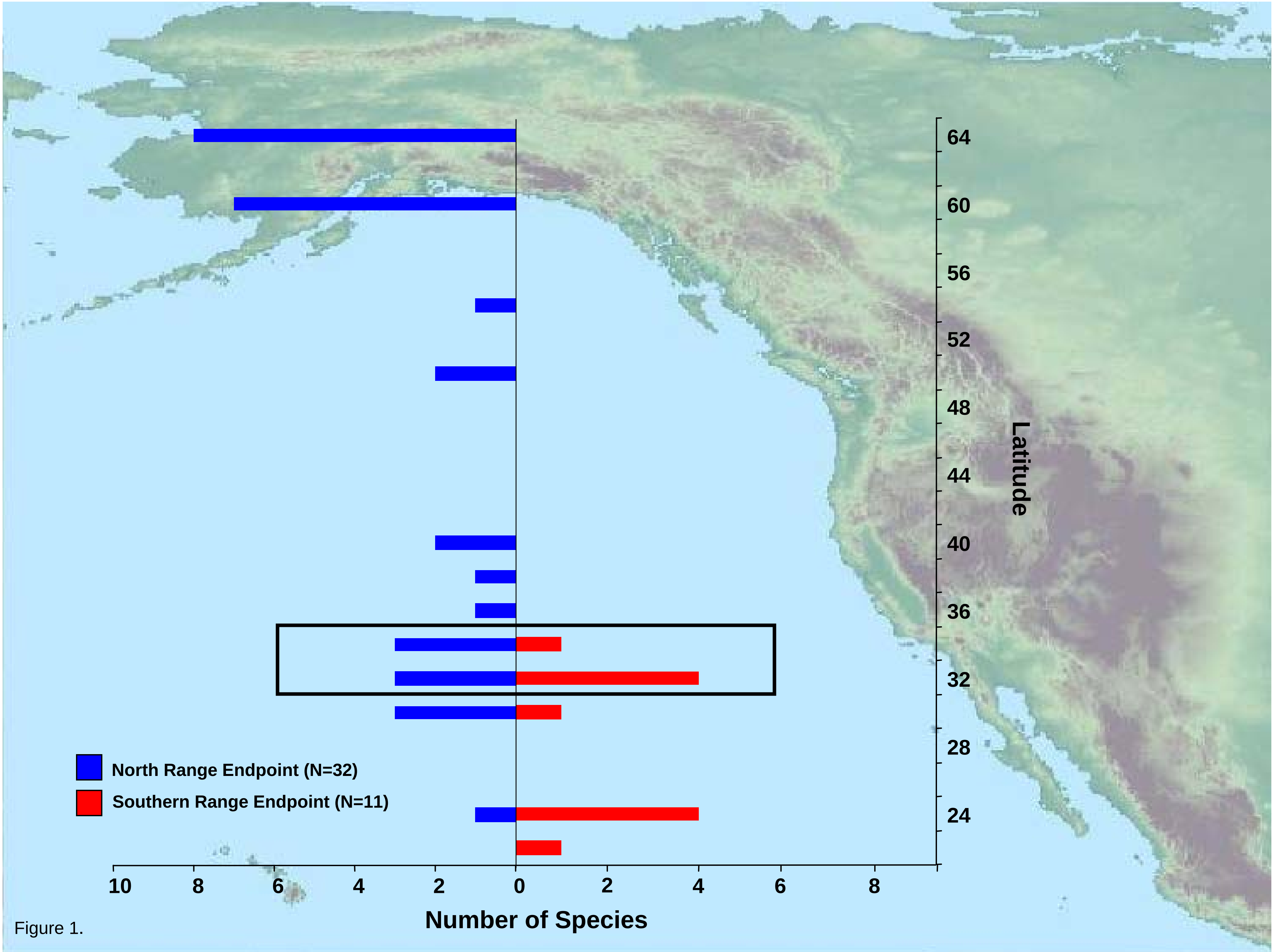
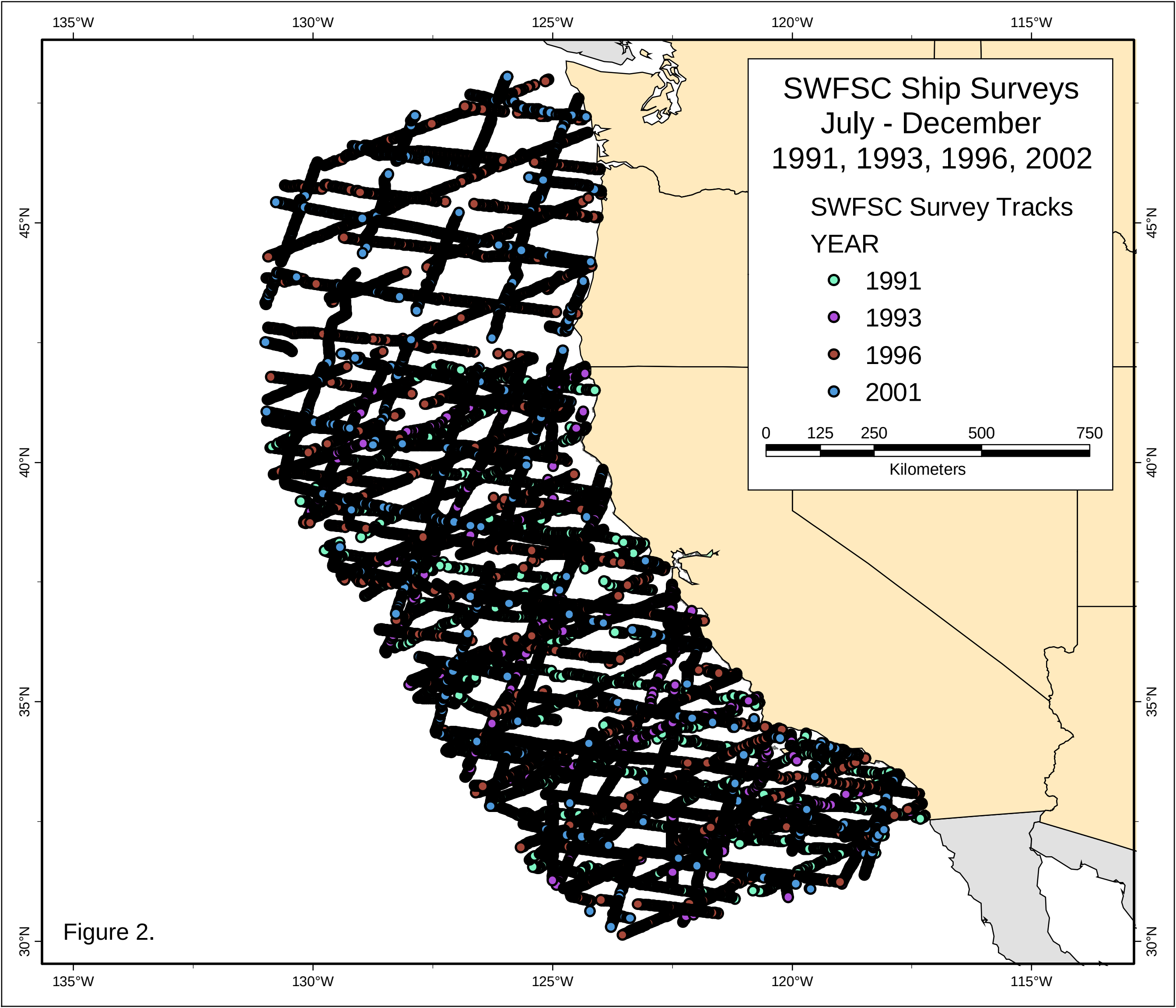

64
60
56
52
48
44
40
36
32
28
24
Latitude
North Range Endpoint (N=32)
Southern Range Endpoint (N=11)
10
8
6
4
2
0
2
4
6
8
Number of Species

Figure 1.


SWFSC Ship Surveys
July - December
1991, 1993, 1996, 2002
SWFSC Survey Tracks
YEAR
1991
1993
1996
2001
0
125
250
500
750
Kilometers
135°W
130°W
125°W
120°W
115°W
45°N
40°N
35°N
30°N
Figure 2.

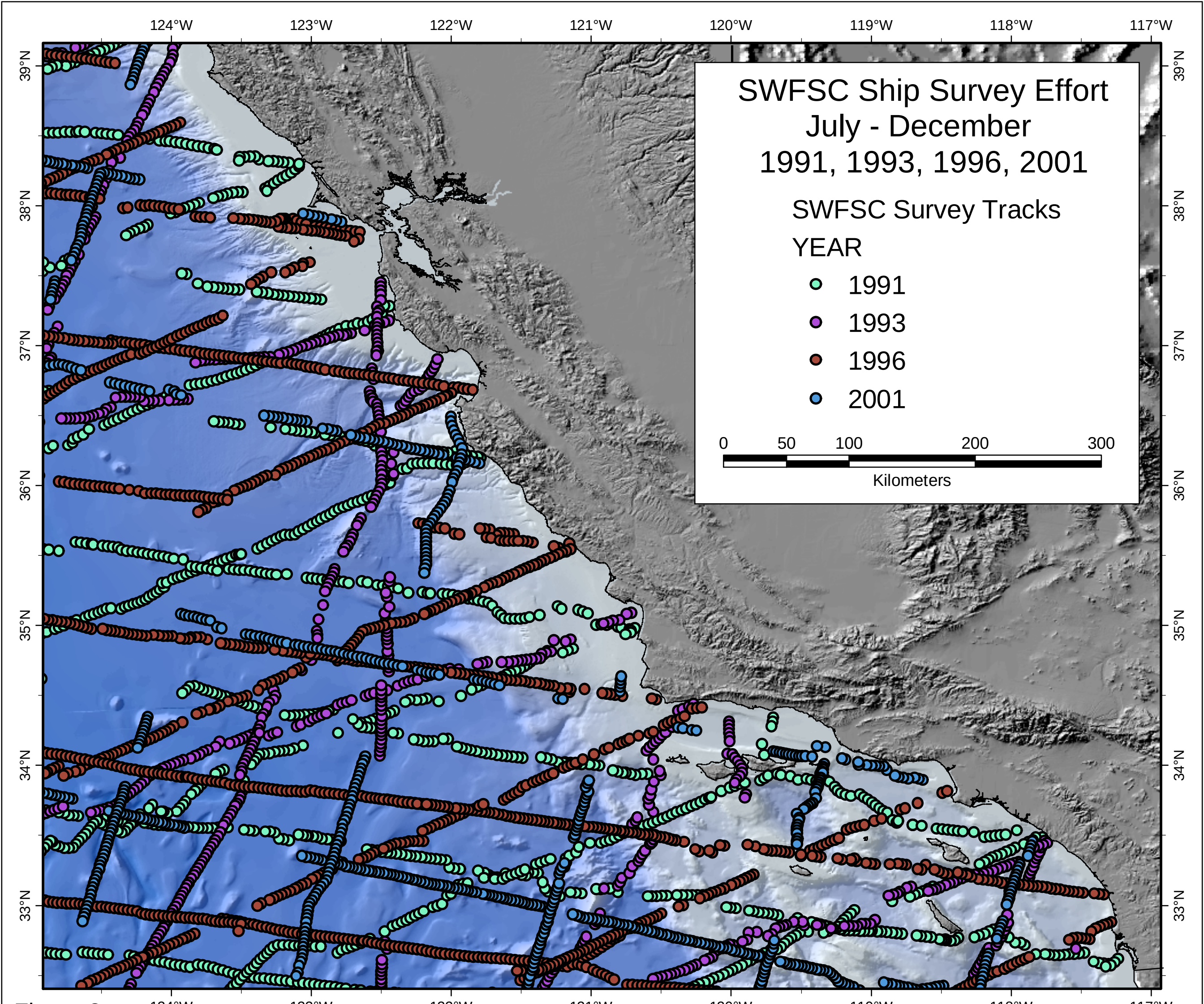
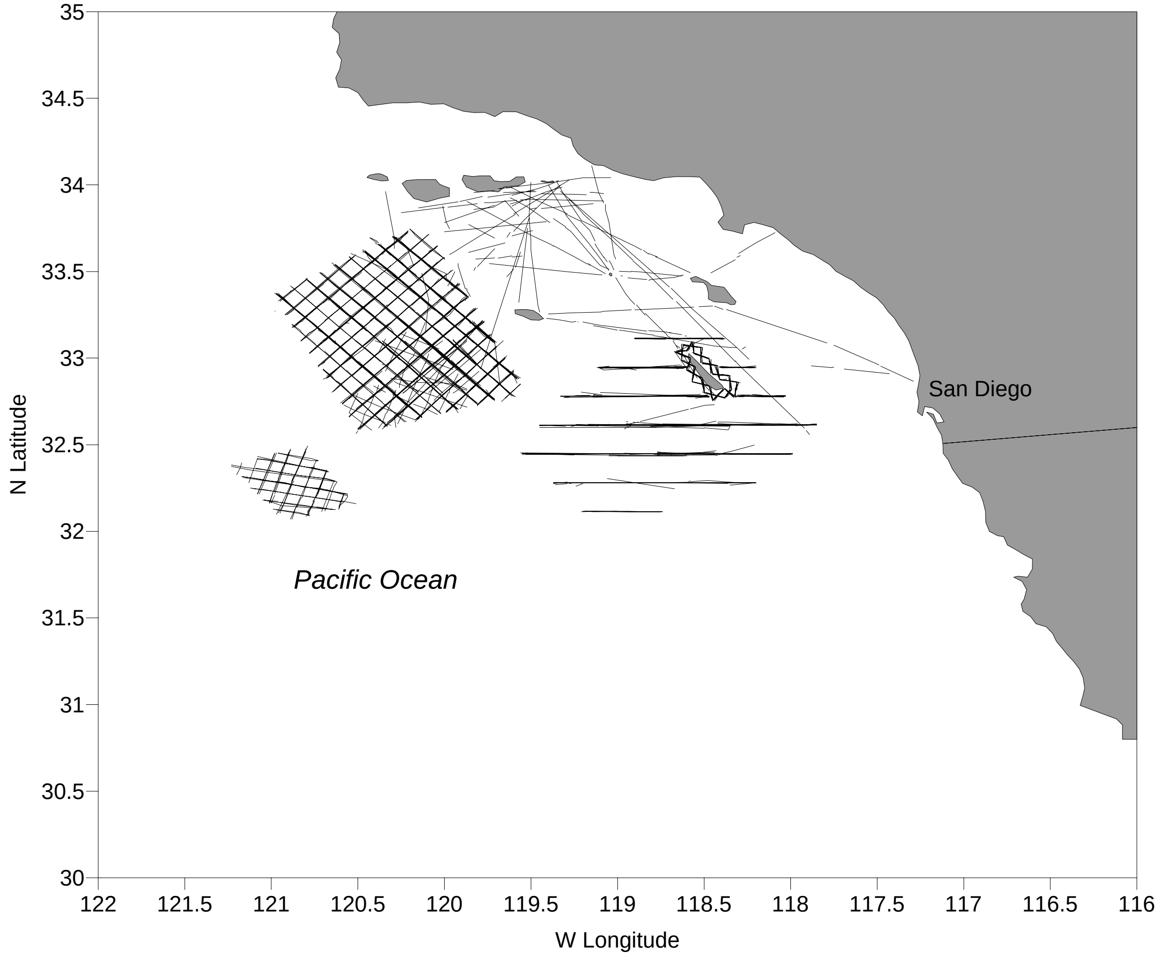
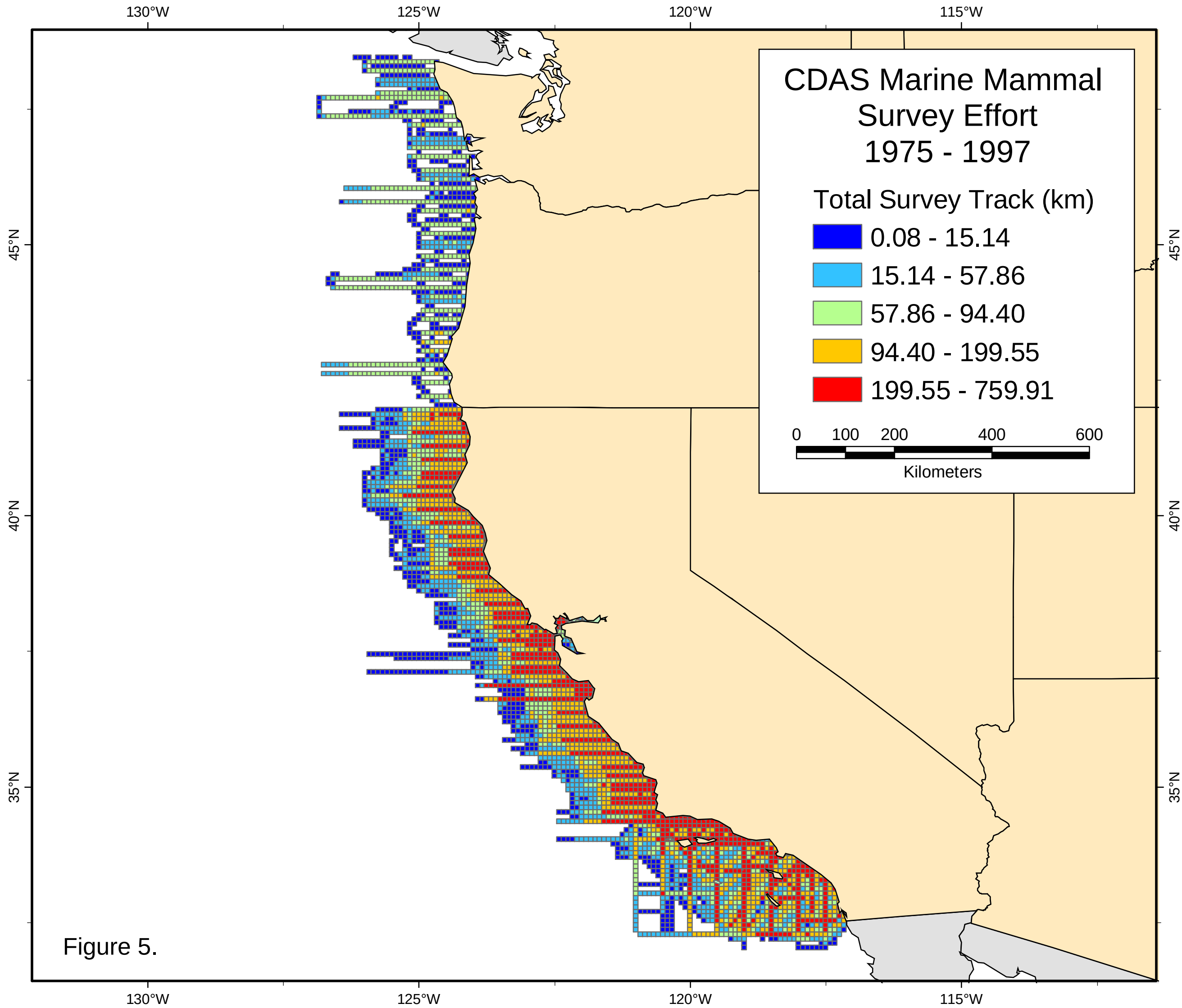

SWFSC Ship Survey Effort
July - December
1991, 1993, 1996, 2001
SWFSC Survey Tracks
YEAR
1991
1993
1996
2001
0
50
100
200
300
Kilometers
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
39°N
38°N
37°N
36°N
35°N
34°N
33°N

Figure 3.



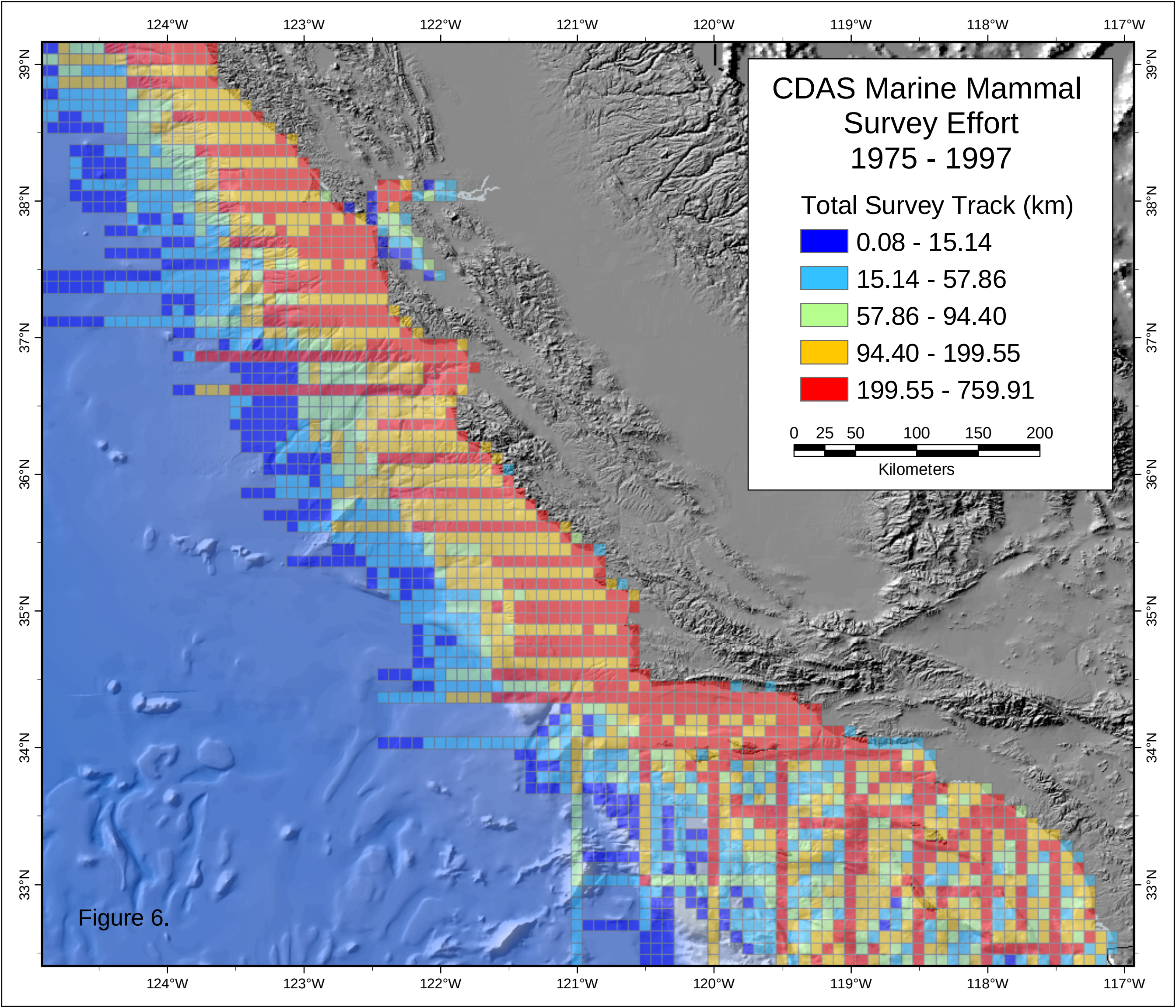
35
34.5
34
33.5
33
32.5
32
31.5
31
30.5
30
N Latitude
122
121.5
121
120.5
120
119.5
119
118.5
118
117.5
117
116.5
116
W Longitude
San Diego
Pacific Ocean

Figure 4.



130°W
125°W
120°W
115°W
45°N
40°N
35°N
CDAS Marine Mammal Survey Effort 1975 - 1997
Total Survey Track (km)
0.08 - 15.14
15.14 - 57.86
57.86 - 94.40
94.40 - 199.55
199.55 - 759.91
0
100
200
400
600
Kilometers

Figure 5.



CDAS Marine Mammal Survey Effort 1975 - 1997
Total Survey Track (km)
0.08 - 15.14
15.14 - 57.86
57.86 - 94.40
94.40 - 199.55
199.55 - 759.91
0 25 50 100 150 200
Kilometers
124°W 123°W 122°W 121°W 120°W 119°W 118°W 117°W
39°N 38°N 37°N 36°N 35°N 34°N 33°N

Figure 6.

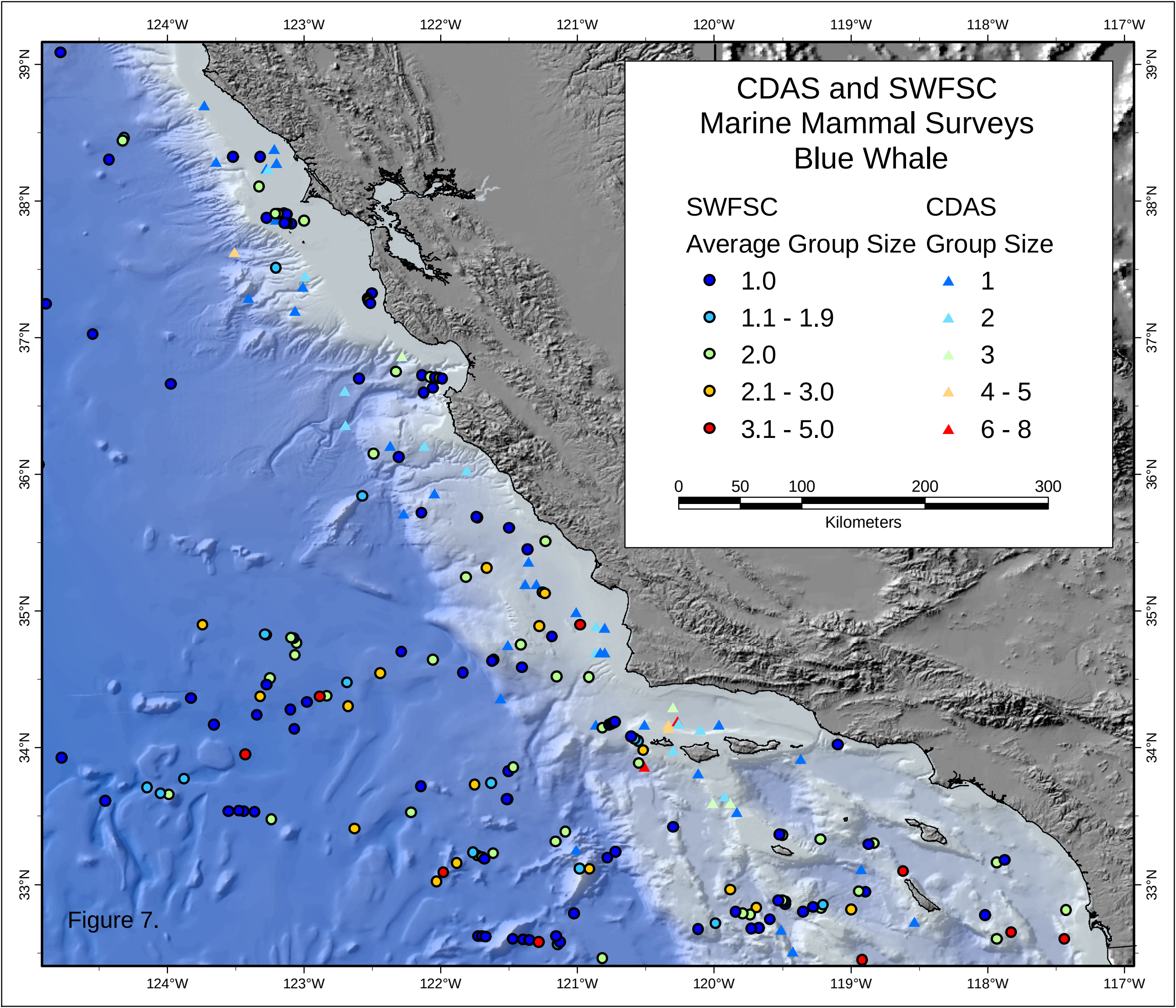

CDAS and SWFSC
Marine Mammal Surveys
Blue Whale
SWFSC
Average Group Size
1.0
1.1 - 1.9
2.0
2.1 - 3.0
3.1 - 5.0
CDAS
Group Size
1
2
3
4 - 5
6 - 8
0 50 100 200 300
Kilometers
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
39°N
38°N
37°N
36°N
35°N
34°N
33°N

Figure 7.

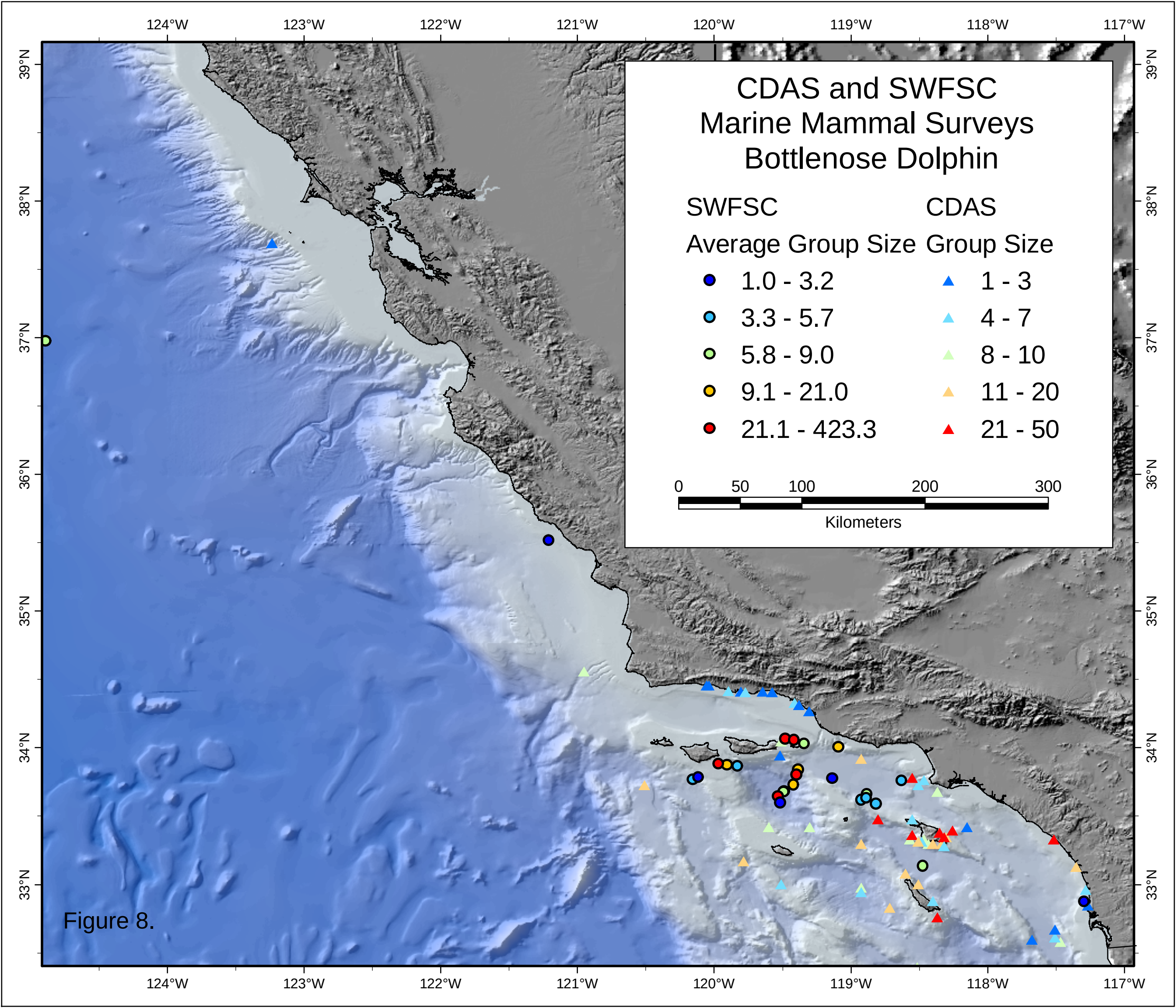
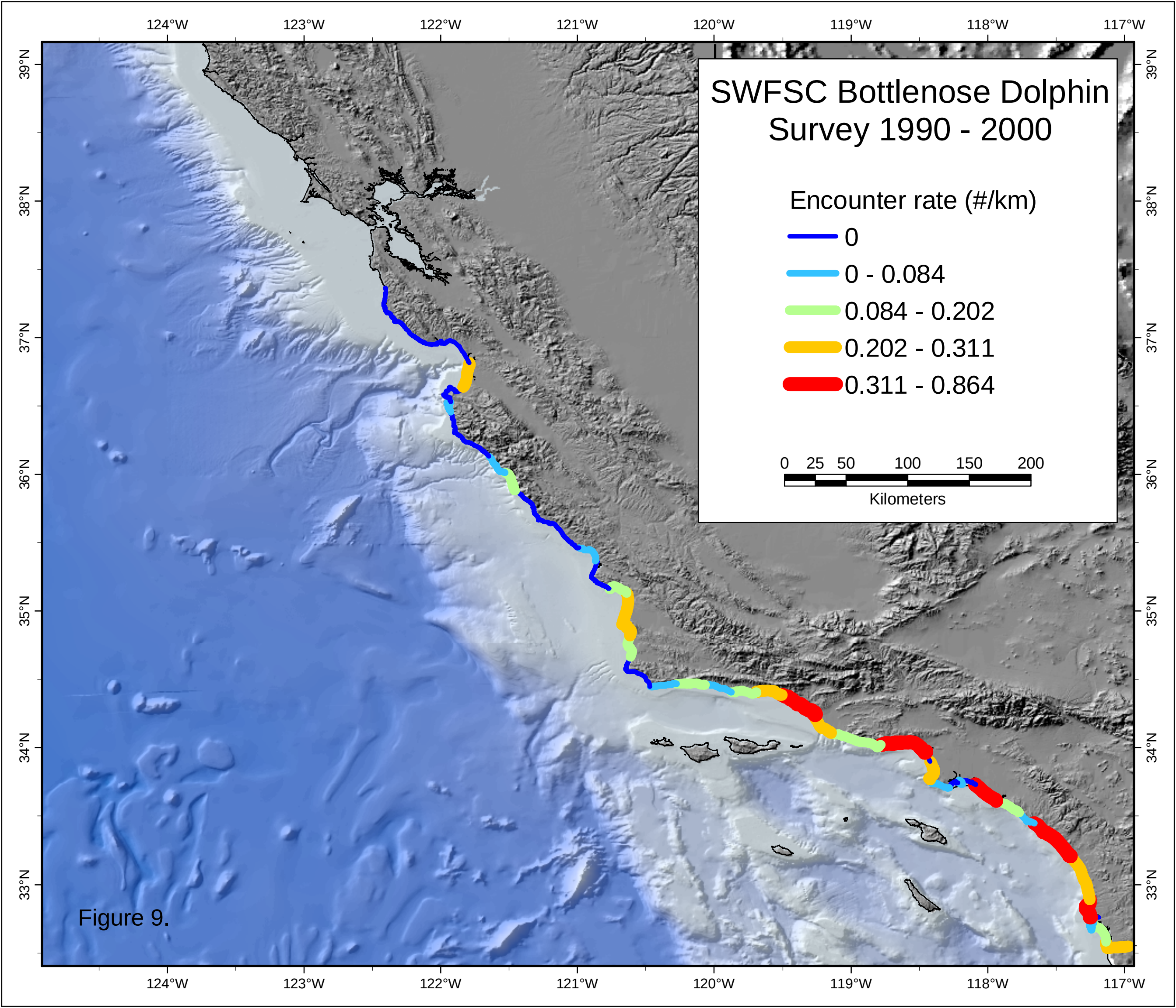
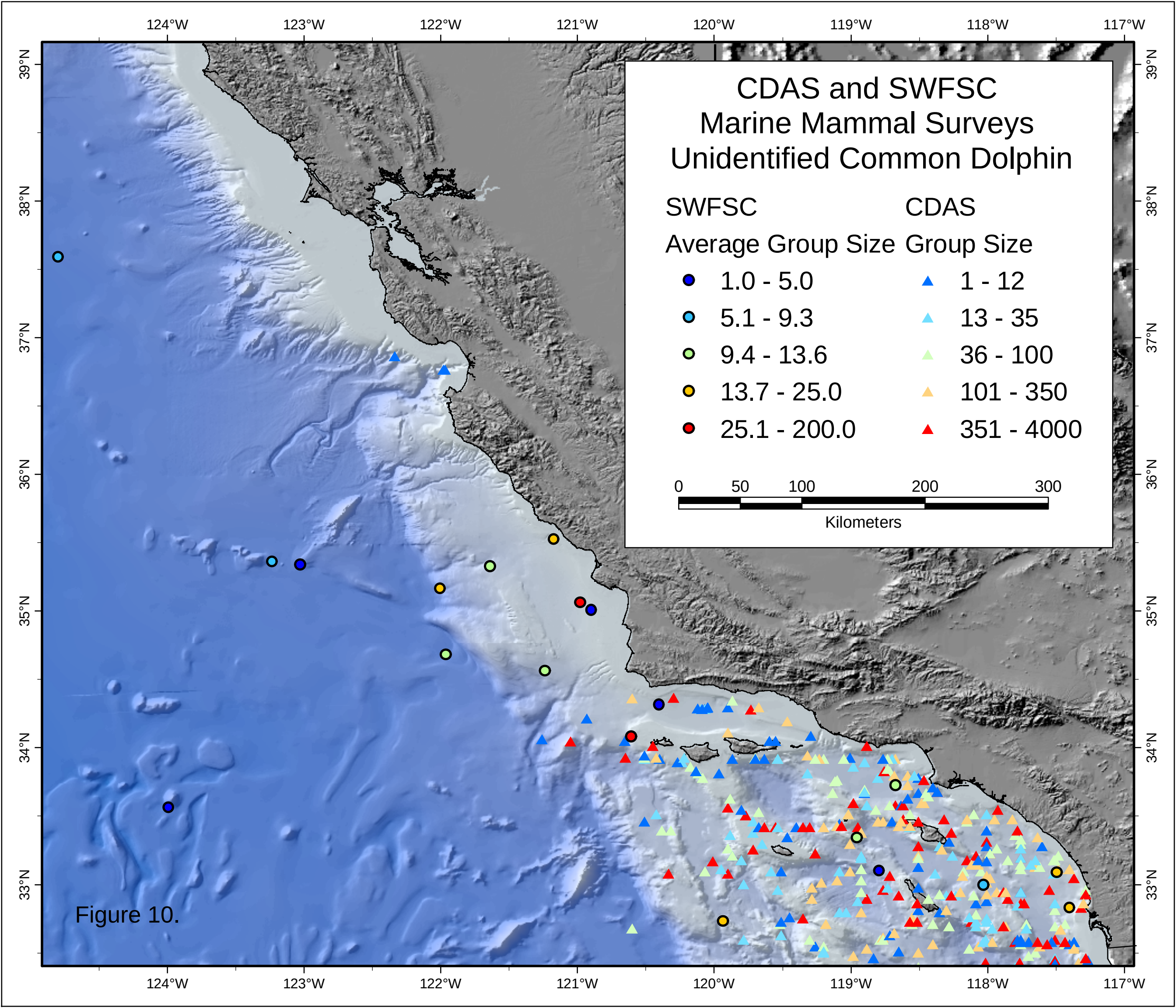

CDAS and SWFSC
Marine Mammal Surveys
Bottlenose Dolphin
SWFSC
Average Group Size
1.0 - 3.2
3.3 - 5.7
5.8 - 9.0
9.1 - 21.0
21.1 - 423.3
CDAS
Group Size
1 - 3
4 - 7
8 - 10
11 - 20
21 - 50
0
50
100
200
300
Kilometers
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
39°N
38°N
37°N
36°N
35°N
34°N
33°N

Figure 8.



SWFSC Bottlenose Dolphin Survey 1990 - 2000
Encounter rate (#/km)
0
0 - 0.084
0.084 - 0.202
0.202 - 0.311
0.311 - 0.864
0 25 50 100 150 200
Kilometers
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
39°N
38°N
37°N
36°N
35°N
34°N
33°N
Figure 9.


CDAS and SWFSC
Marine Mammal Surveys
Unidentified Common Dolphin
SWFSC
Average Group Size
1.0 - 5.0
5.1 - 9.3
9.4 - 13.6
13.7 - 25.0
25.1 - 200.0
CDAS
Group Size
1 - 12
13 - 35
36 - 100
101 - 350
351 - 4000
0 50 100 200 300
Kilometers
124°W 123°W 122°W 121°W 120°W 119°W 118°W 117°W
39°N 38°N 37°N 36°N 35°N 34°N 33°N
Figure 10.

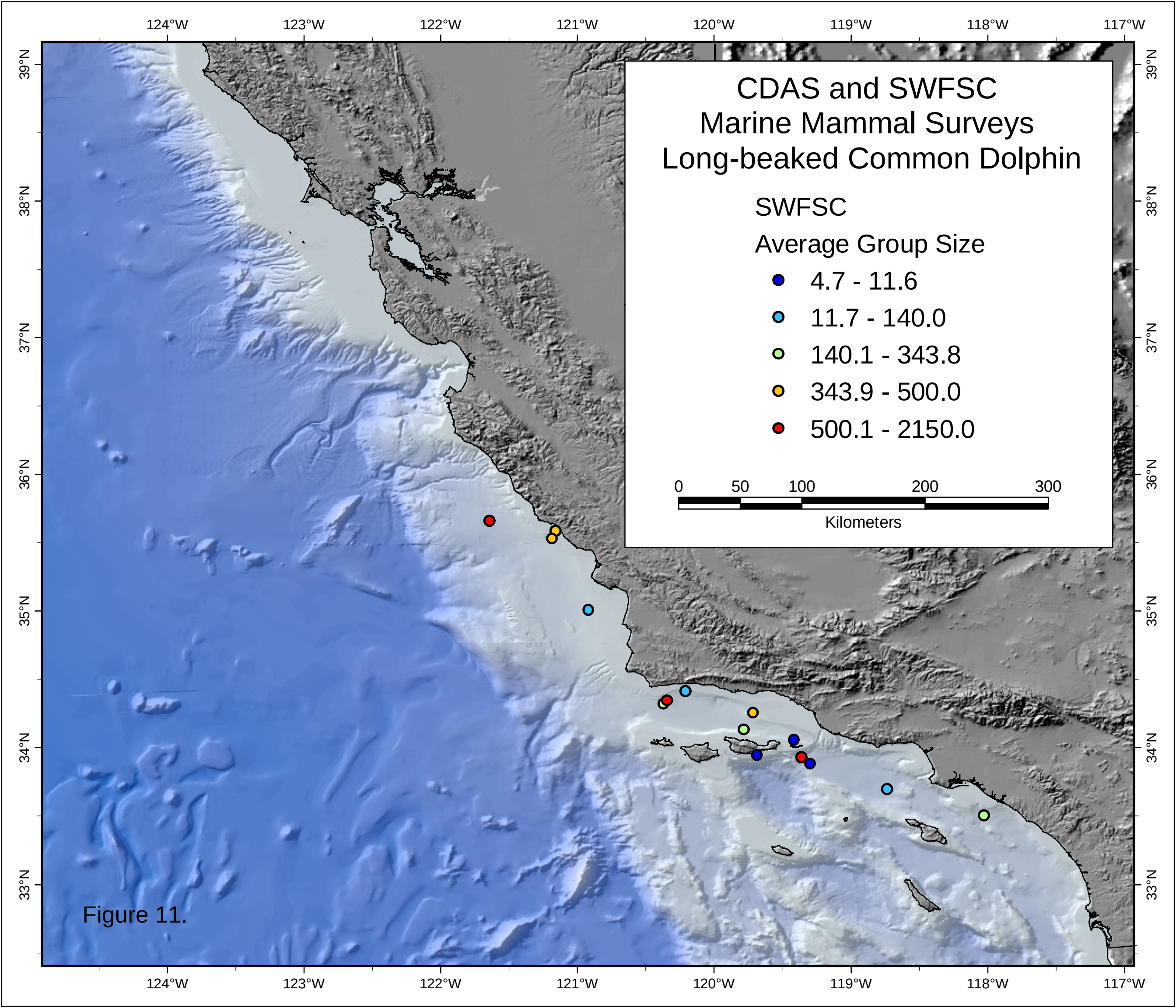
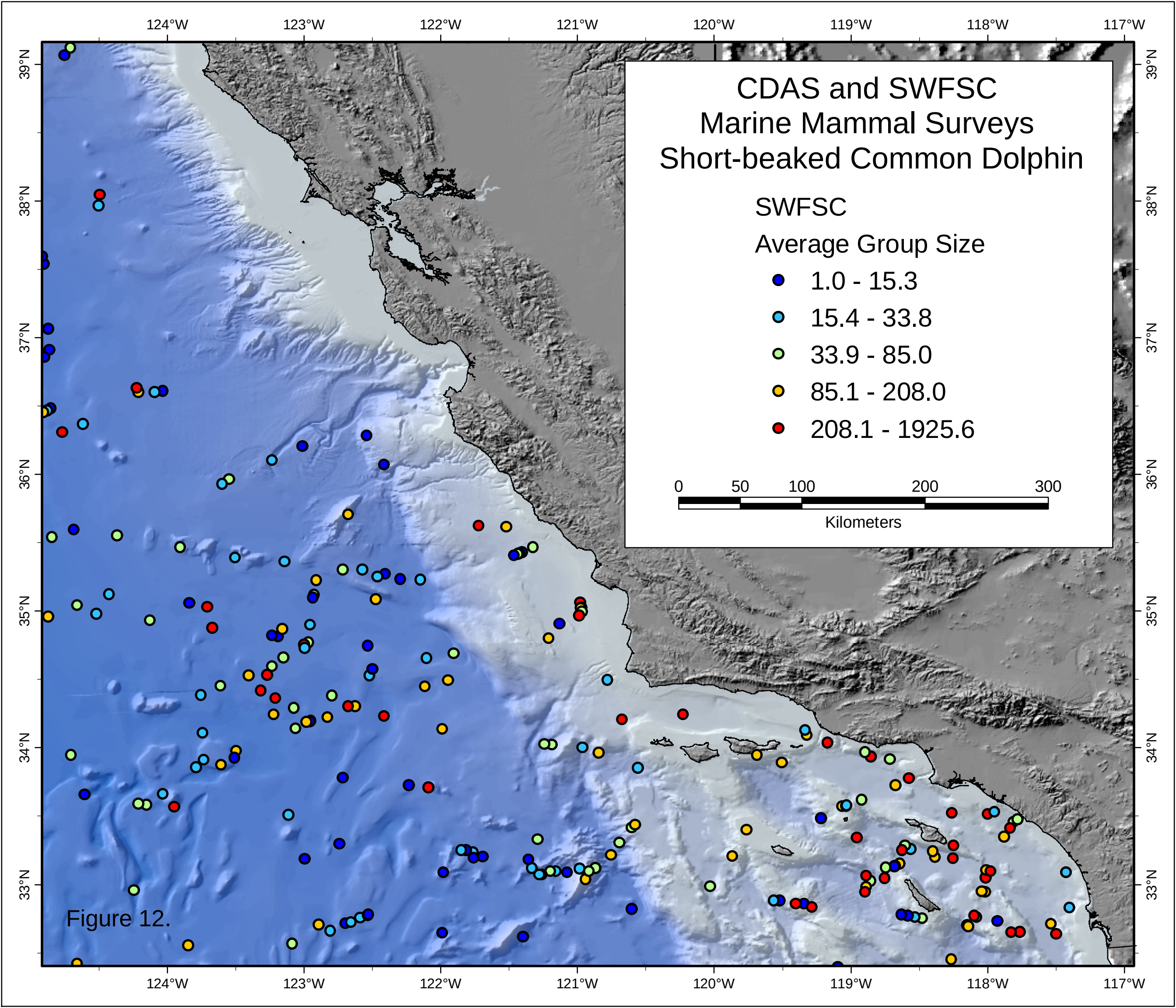

CDAS and SWFSC
Marine Mammal Surveys
Long-beaked Common Dolphin
SWFSC
Average Group Size
4.7 - 11.6
11.7 - 140.0
140.1 - 343.8
343.9 - 500.0
500.1 - 2150.0
0
50
100
200
300
Kilometers
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
39°N
38°N
37°N
36°N
35°N
34°N
33°N

Figure 11.


CDAS and SWFSC
Marine Mammal Surveys
Short-beaked Common Dolphin
SWFSC
Average Group Size
1.0 - 15.3
15.4 - 33.8
33.9 - 85.0
85.1 - 208.0
208.1 - 1925.6
0
50
100
200
300
Kilometers
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
39°N
38°N
37°N
36°N
35°N
34°N
33°N
Figure 12.

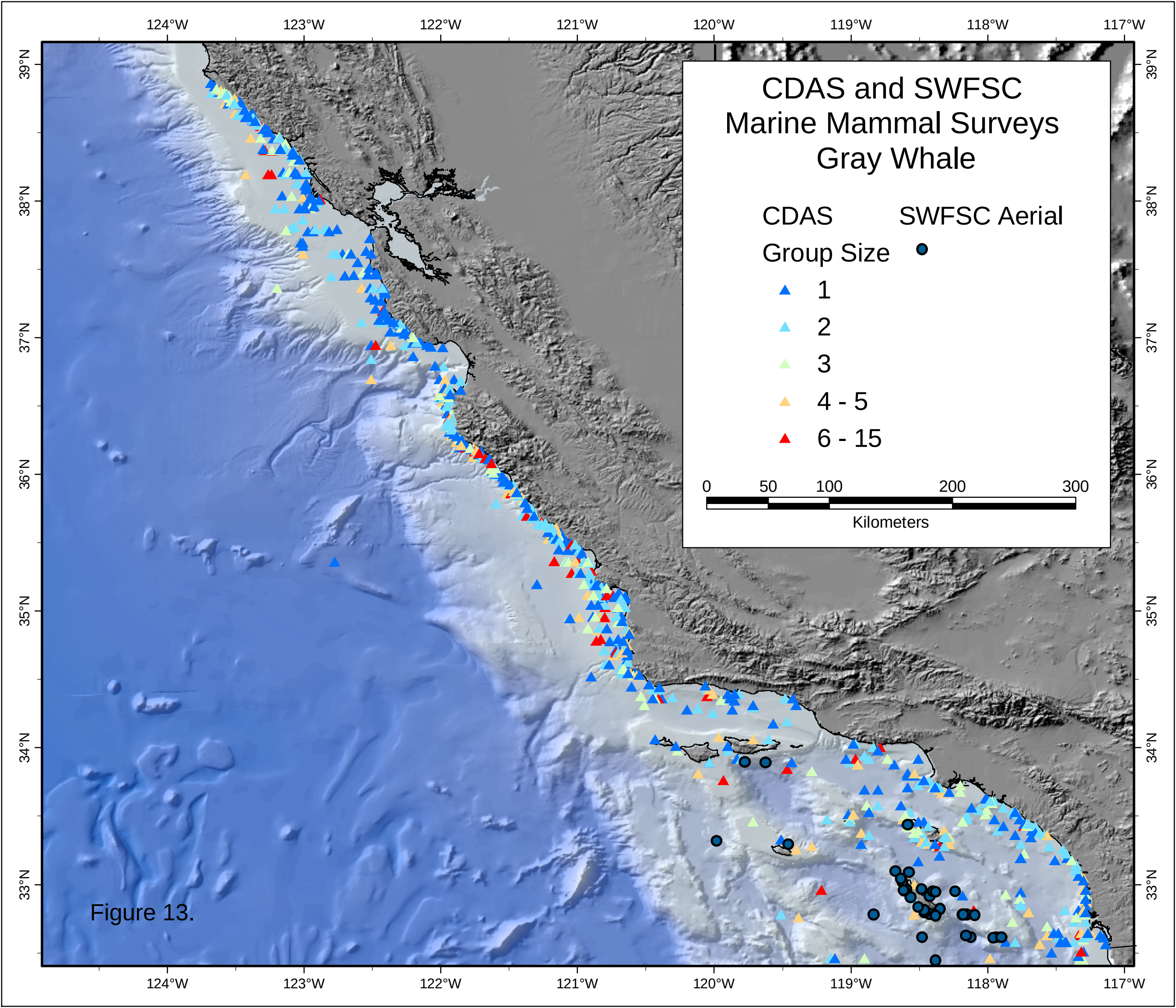

CDAS and SWFSC
Marine Mammal Surveys
Gray Whale
CDAS
SWFSC Aerial
Group Size
1
2
3
4 - 5
6 - 15
0
50
100
200
300
Kilometers
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
39°N
38°N
37°N
36°N
35°N
34°N
33°N

Figure 13.

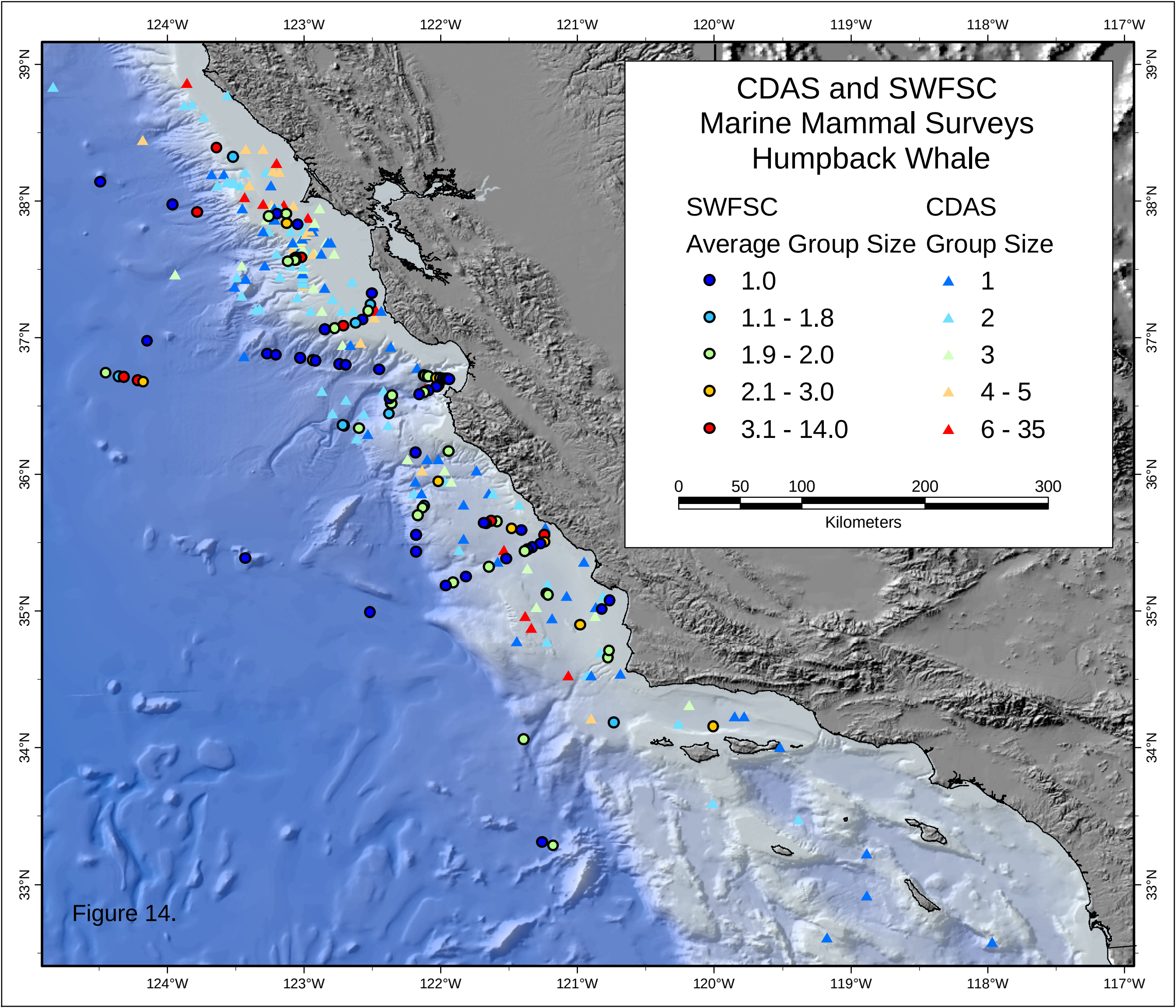
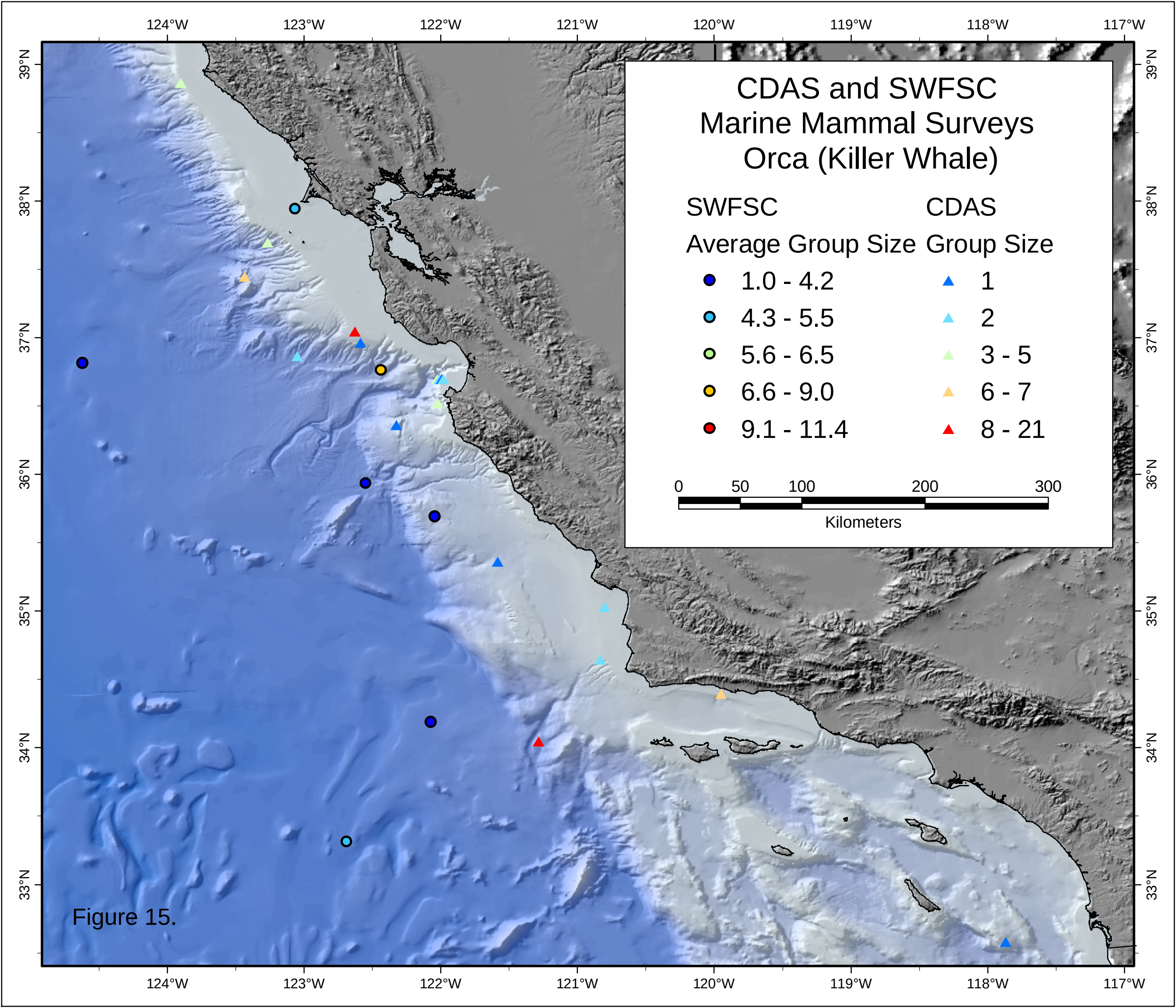
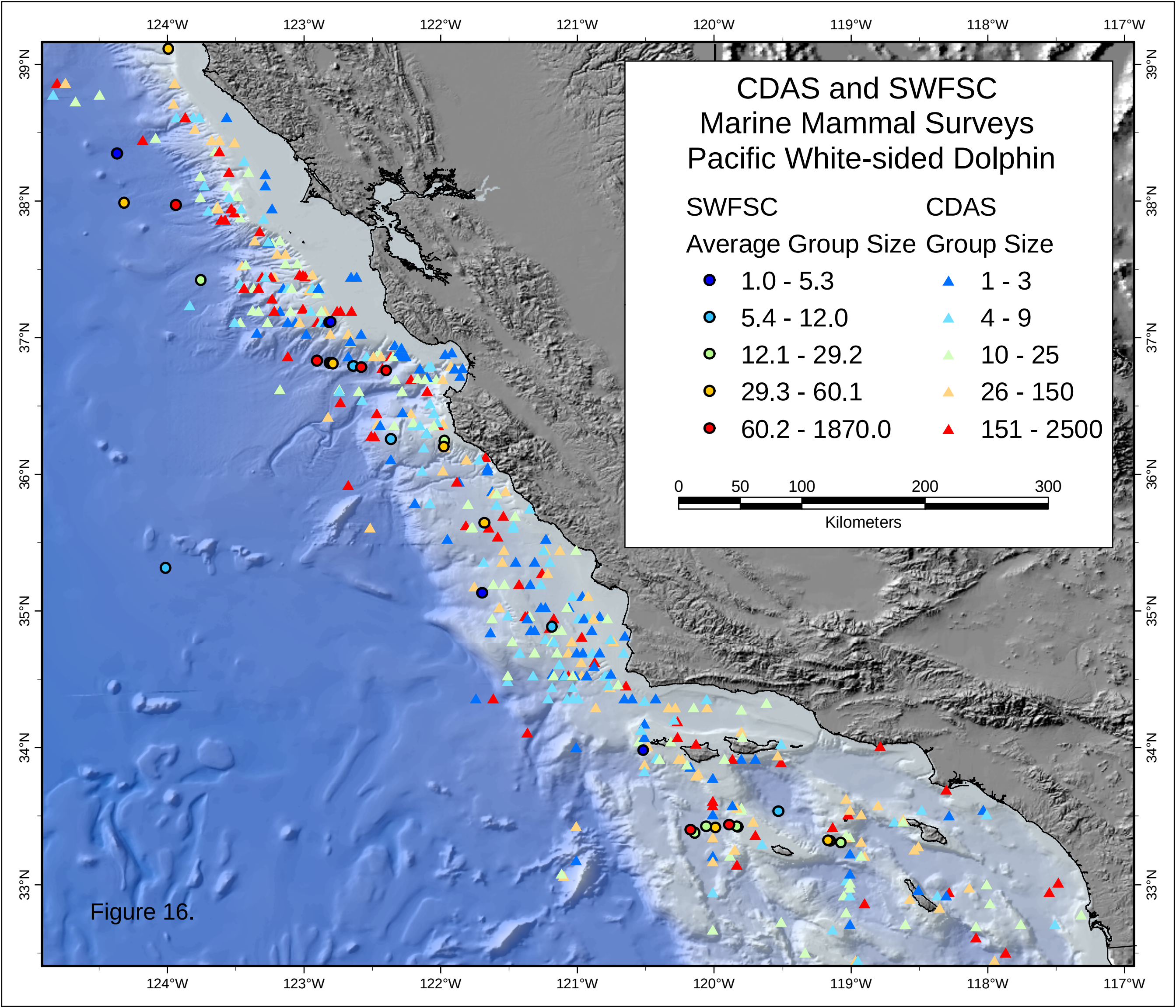

CDAS and SWFSC
Marine Mammal Surveys
Humpback Whale
SWFSC
Average Group Size
1.0
1.1 - 1.8
1.9 - 2.0
2.1 - 3.0
3.1 - 14.0
CDAS
Group Size
1
2
3
4 - 5
6 - 35
0
50
100
200
300
Kilometers
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
39°N
38°N
37°N
36°N
35°N
34°N
33°N

Figure 14.


CDAS and SWFSC
Marine Mammal Surveys
Orca (Killer Whale)
SWFSC
Average Group Size
1.0 - 4.2
4.3 - 5.5
5.6 - 6.5
6.6 - 9.0
9.1 - 11.4
CDAS
Group Size
1
2
3 - 5
6 - 7
8 - 21
0
50
100
200
300
Kilometers
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
39°N
38°N
37°N
36°N
35°N
34°N
33°N
Figure 15.



CDAS and SWFSC
Marine Mammal Surveys
Pacific White-sided Dolphin
SWFSC
Average Group Size
1.0 - 5.3
5.4 - 12.0
12.1 - 29.2
29.3 - 60.1
60.2 - 1870.0
CDAS
Group Size
1 - 3
4 - 9
10 - 25
26 - 150
151 - 2500
0
50
100
200
300
Kilometers
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
39°N
38°N
37°N
36°N
35°N
34°N
33°N

Figure 16.

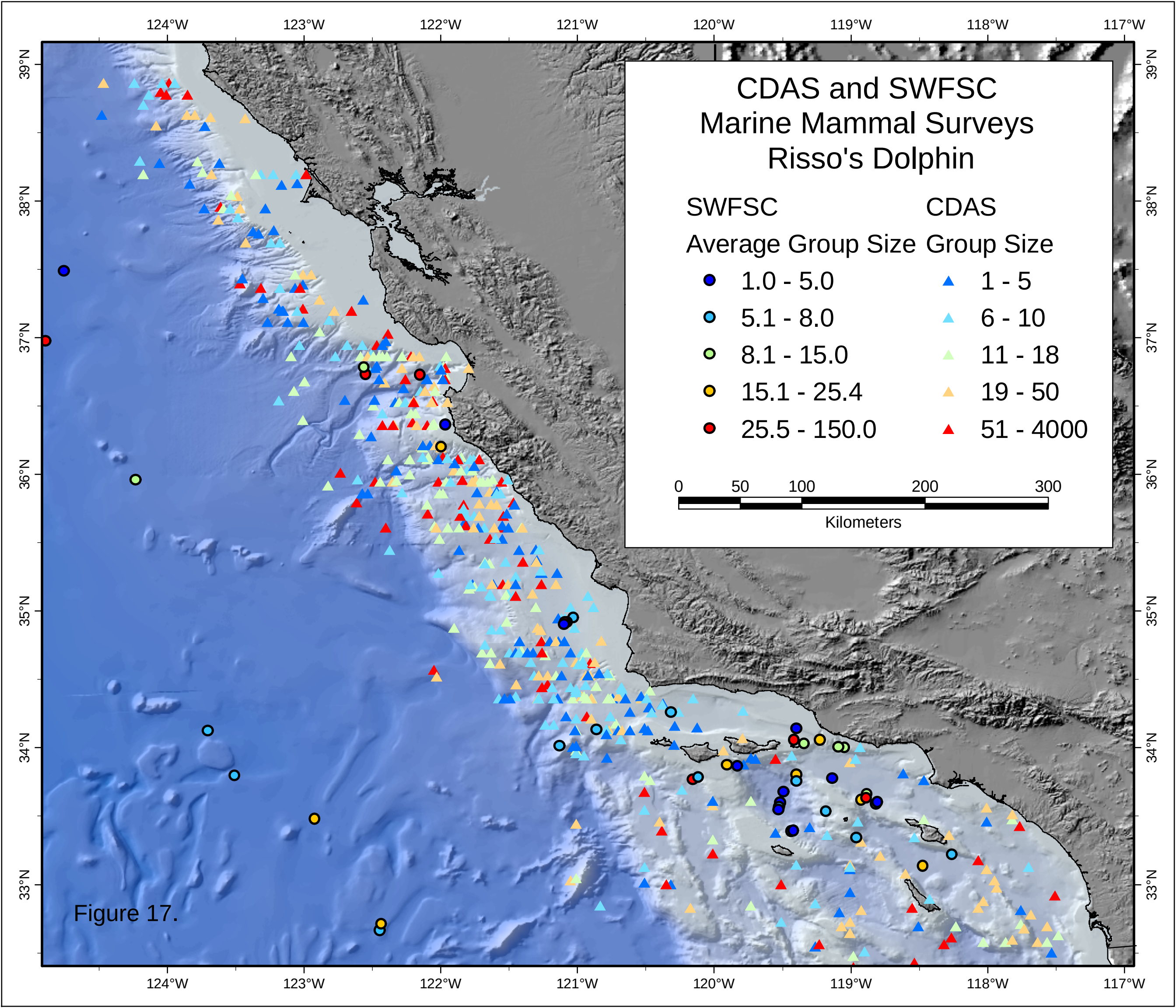

CDAS and SWFSC
Marine Mammal Surveys
Risso's Dolphin
SWFSC
Average Group Size
1.0 - 5.0
5.1 - 8.0
8.1 - 15.0
15.1 - 25.4
25.5 - 150.0
CDAS
Group Size
1 - 5
6 - 10
11 - 18
19 - 50
51 - 4000
0
50
100
200
300
Kilometers
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
39°N
38°N
37°N
36°N
35°N
34°N
33°N

Figure 17.